OPERATOR'S MANUAL

GP15T

ELECTRO-MOTIVE

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GP15T

1st Edition

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ELECTRO-MOTIVE

• • A Service Department Publication • •

Electro-Motive Division Of General Motors La Grange, Illinois 60525

NOTICE

Information appearing in this manual is intended as an aid in explaining locomotive equipment used by the operator. Generally the information is applicable to basic locomotive equipment, however, some frequently requested optional equipment receives coverage. When special extra equipment is involved, consult specific drawings or instructions as provided by the railroad.

Information contained in this manual is based on data available when released for printing. Minor equipment differences are due to changes made after the manual was published.

INTRODUCTION

This manual has been prepared as a guide for railroad personnel engaged in the operation of the 1500 horsepower General Motors Model GP15T diesel-electric locomotive.

Locomotive description and operating instructions are divided into four sections as follows:

1. General Description – Describes principal equipment components.

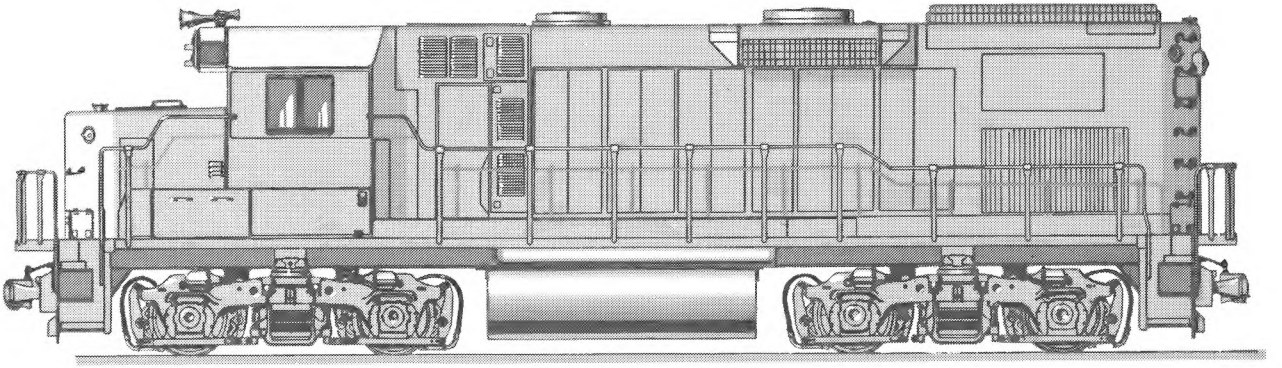
2. Controls – Explains functions of controls used to start and operate the locomotive. Indicating devices to monitor certain locomotive systems also receive coverage.

3. Operation – Outlines procedures for locomotive operation.

4. Troubleshooting – Describes probable causes of operating trouble and suggests operator action.

To be of most benefit to the reader, these sections should be read in sequence.

Information concerning equipment maintenance, adjustment, and testing is contained in other EMD publications pertaining to this model.



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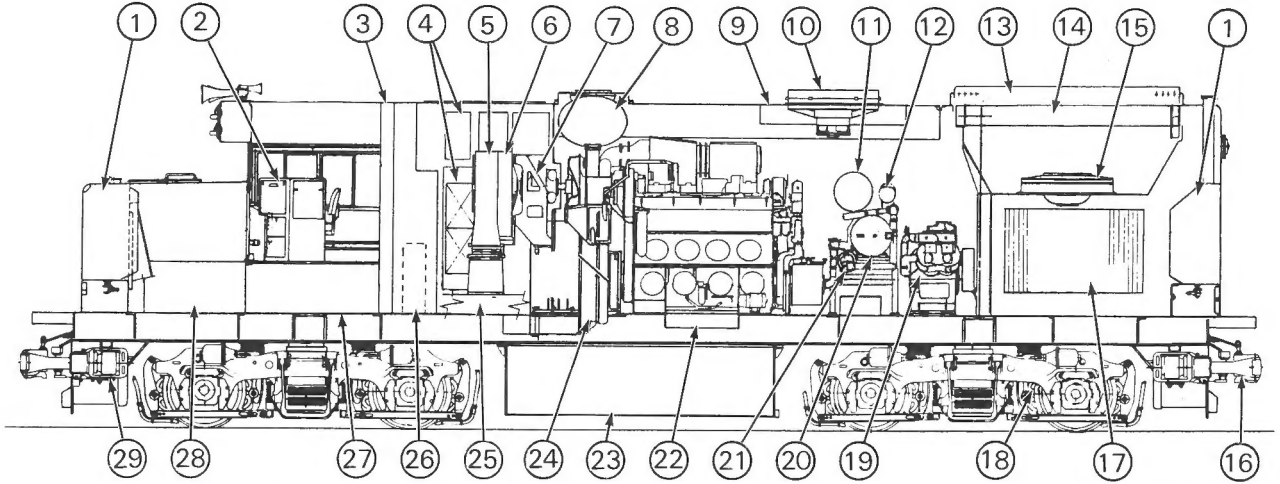
GP15T Locomotive



1. Sand Box And Filler
2. Control Stand
3. Control Cabinet
4. Carbody Air Filters
5. Traction Motor Blower
6. Generator Blower
7. Auxiliary Generator
8. Exhaust Silencer
9. Dynamic Brake Hatch
10. Dynamic Brake Blower
11. Water Tank
12. Fuel Filter
13. Radiator Shutters
14. Water Cooling Radiators
15. Cooling Fan
16. Coupler, E-Type
17. Cooling Air Inlet
18. Truck, GP-Type
19. Air Compressor
20. Lube Oil Filter
21. Lube Oil Cooler
22. Engine, 8-645E3C
23. Fuel Tank
24. Main Generator
25. Traction Motor Cooling Air Duct
26. Control Cabinet Air Filter
27. Air Brake Equipment Access
28. Battery Access
29. Draft Gear

Typical GP15T Locomotive General Arrangement

GENERAL DATA

Model Designation	GP15T
Locomotive Type	(B-B) 0440
Locomotive Horsepower	1500
Diesel Engine	
Model	645E3C
Number Of Cylinders	8
Cylinder Arrangement	45° - "V"
Cylinder Bore And Stroke	230 x 254 mm (9-1/16" x 10")
Operating Principle	Turbocharged 2 Stroke Cycle Unit Fuel Injection Water Cooled
Compression Ratio	16:1
Engine Speed	
Full	904 RPM
Idle	300 RPM
Low Idle	235 RPM
Main Generator Model	AR10-D14
Traction Alternator (Rectified Output)	AR10
Nominal Voltage (DC)	600
Frequency At 900 RPM	75 Hz
Maximum Continuous Current	4200 Amperes
Companion Alternator	D14
Number Of Poles	16
Nominal Voltage (AC)	215
Frequency (At 900 RPM)	120 Hz
Auxiliary Generator	
Basic Rating	10 kW
Voltage DC	74
Traction Motors	
Model	D77
Number	4
Type	DC, Series Wound, Axle Hung

GENERAL DATA (Cont'd)

Maximum Continuous Current
With 62:15 Gearing . . . . . 920 Amperes

Driving Wheels . . . . . 4 Pairs
Diameter . . . . . 1 016 mm (40″)

Air Compressor
Type . . . . . Two Stage
Number Of Cylinders 3
Displacement at 900 RPM . . . . . 7.19 m^3 (254 Cu. Ft.)/Min.
Lube Oil Capacity . . . . 38 Liters (10 U.S. Gal.)

Storage Battery
Number Of Cells 32
Voltage 64

Supplies
Engine Lubricating Oil Capacity . . . 511 Liters (135 U.S. Gal.)
Cooling Water Capacity . . . . . 795 Liters (210 U.S. Gal.)
Sand
Basic . . . . . 1.58 m^3 (56 Cu. Ft.)
Special . . . . . 2.04 m^3 (72 Cu. Ft.)
Fuel
Basic . . . . . 9 085 Liters (2400 U.S. Gal.)

Major Dimensions
Track Gauge . . . . . 1.435 m (4′ 8-1/2″)
Distance Between Coupler Pulling Faces . . . . . 16.739 m (54′ 11″)
Maximum Height Over Rail . . . . . 4.636 m (15′ 2-1/2″)
Maximum Width Over Hand Rail Supports . . . 3.127 m (10′ 3-1/8″)
Approximate Weight On Rails . . . 110 678 kg (244,000 Lbs)
Weight On Drivers 100%

Curve Negotiation

Truck swing limits single unit curve negotiation to a 49° or 36.6 m (120 ft.) radius curve.

Two units coupled are limited by coupler swing to a 34° or 51.8 m (170 ft.) radius curve.

Locomotive coupled to 50 ft. car is limited by coupler swing to a 23° or 74.7 m (245 ft.) radius curve.

TABLE OF NOMINAL SPEEDS

GEAR RATIO	Minimum Speeds*								Maximum Speed**	
	Continuous At 920A		1 Hour At 1020A		1/2 Hour At 1070A		1/4 Hour At 1150A			
	km/h	MPH	km/h	MPH	km/h	MPH	km/h	MPH	km/h	MPH
65:12	11.27	7.0	9.33	5.8	8.53	5.3	7.40	4.6	85	53
62:15	14.81	9.2	12.23	7.6	11.27	7.0	9.66	6.0	113	70
61:16	15.93	9 9	13.36	8.3	12.07	7.5	10.46	6.5	122	76
60:17	17.22	10.7	14.32	8.9	13.04	8.1	11.27	7.0	132	82

*These ratings are non-accumulative.

**Based on rated RPM of traction motors and 1 016 mm (40") wheels

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SECTION 1
GENERAL DESCRIPTION

INTRODUCTION

The General Motors Model GP15T diesel-electric locomotive, illustrated in the introduction, is equipped with a turbocharged 8-cylinder 645E3C diesel engine which drives the main generator. Electrical power from the main generator is distributed to the traction motors through the high voltage control cabinet. Each of the four traction motors is geared directly to a pair of driving wheels. The gear ratio of the traction motor to the wheel axle determines the maximum operating speed of the locomotive.

The basic locomotive is arranged and equipped so that the short hood or cab end is considered the front or forward part of the unit. However, the locomotive operates equally well in either direction. On special order, controls may be arranged so that the long hood end is forward or dual controls may be provided.

The locomotive is designed for single unit or multiple unit operation. When coupled together for multiple unit operation, all units are controlled simultaneously, through jumper cables, from the control stand in the cab of the lead unit.

LOCOMOTIVE OPERATION

The majority of components on a locomotive perform functions relating to either the diesel engine or the electrical transmission of power to the driving wheels.

The diesel engine is the source of locomotive power. Storage batteries provide the energy required to start the engine. The fuel prime/engine start switch controls

battery power to the starting motor solenoids mounted at the lower rear right hand side of the engine. These electrical solenoids engage the starting motor pinions with the engine ring gear. When each motor pinion is engaged, battery power is applied to the starting motors to crank the engine.

Once started, the engine supplies all power to drive three electrical generators, a multi-cylinder air compressor, and all cooling and engine support systems.

The three electrical generators, the direct current traction motors, and the locomotive control system, form the electrical transmission.

The main generator rotates at engine speed. It supplies high voltage AC power to a rectifier assembly which then delivers high voltage DC power to the traction motors for locomotive pulling power.

The companion alternator is physically coupled to the main generator. It supplies current to excite the main generator field and to power the radiator cooling fan, the inertial filter blower motor (on units so equipped), and various transductors and control devices.

The auxiliary generator provides excitation current to the companion alternator. The auxiliary generator also supplies the power needed for control, cab heating, locomotive lighting, and battery charging circuits.

Each traction motor is directly geared to an axle and pair of driving wheels. The trucks, which house the motor and wheel arrangements, support all of the locomotive weight, yet provide for flexibility to turn the locomotive and absorb many of the shocks while maintaining maximum traction for the wheels.

The excitation and power control system enables the locomotive to utilize the maximum horsepower of the diesel engine over wide variations in locomotive speed and load. This system consists mainly of electronic components, most of which are mounted on plug-in circuit modules located in the electrical cabinet.

Except for manual operation of the cab controls, locomotive operation is controlled automatically by the excitation and power control system. Various alarms and safety devices will alert the operator should any operating difficulties occur.

SECTION 2

CONTROLS AND INDICATING DEVICES

INTRODUCTION

This section provides a brief description of controls and indicating devices used by the operator. Although some equipment receiving coverage is not used during normal operation, it is included to familiarize the operator with its function.

The majority of controls and indicating devices used by the operator are located in the locomotive cab. Engine starting and monitoring equipment is located in the engineroom.

CAB EQUIPMENT

Operating equipment is located in the locomotive cab at two locations: the operator's control stand, and the control cabinet.

OPERATOR'S CONTROL STAND

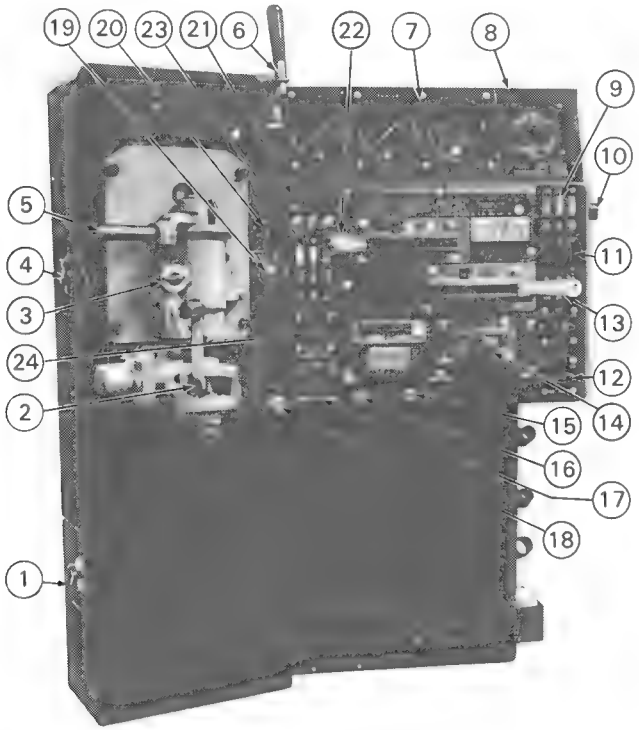
The operator's control stand, Fig. 2-1, contains switches, gauges, and operating handles used by the operator. The individual components are described, together with their functions, in the following paragraphs.

CONTROLLER

The following operating handles are located on the locomotive controller, Fig. 2-2.

DYNAMIC BRAKE HANDLE (If Equipped)

A separate handle is provided for control of dynamic brakes, Fig. 2-3, it is uppermost on the controller panel and is moved from left to right to increase braking effort.



1. Multiple Unit Valve
2. Independent Brake Valve
3. Cut-Off Valve
4. Trainline Air Pressure Adjustment Valve
5. Automatic Brake Valve
6. Air Horn Valve
7. Air Gauges
8. Load Current Indicating Meter
9. Control And Operating Switches
10. Light Dimmer
*11. Dynamic Brake Circuit Breaker
12. Headlight Switch-Front
13. Throttle Handle
14. Reverser Handle
15. Ground Reset Button
16. Attendant Call Button
17. Headlight Switch-Rear
18. Bell Ringer Valve
19. Manual Sand Lever Switch
*20. Lead Truck Sand Switch
21. Indicator Light Panel
*22. Dynamic Brake Handle
23. Ground And Gauge Light Switches
*24. Cab Heater Switches

*If so equipped.

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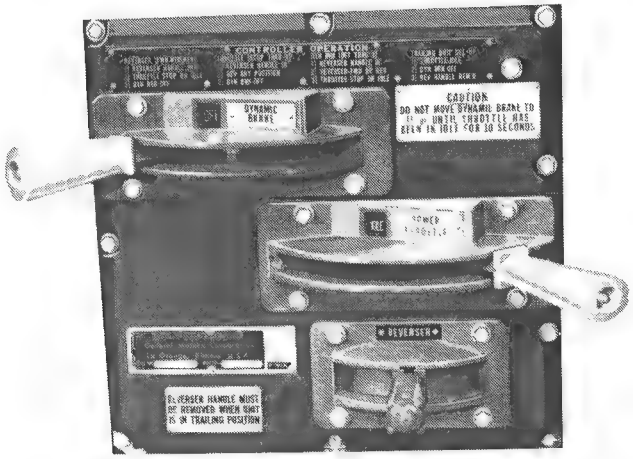
Fig.2-1 – Typical Operator's Control Stand



NOTE
Dynamic brake on special order. 25873

Fig.2-2 – Locomotive Controller

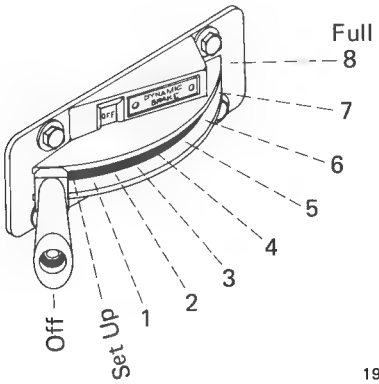


Fig.2-3 – Dynamic Brake Handle

The handle grip is somewhat out-of-round with the flattened surfaces vertical to distinguish it from the throttle handle, which has its flattened surfaces horizontal. The brake handle has two detent positions; OFF and SETUP, and an operating range 1 through FULL 8, through which the handle moves freely without notching. Mechanical interlocking prevents the dynamic brake handle from being moved out of the OFF position unless the throttle is in IDLE and the reverser is positioned for either forward or reverse operation.

CAUTION

During transfer from power operation to dynamic braking, the throttle must be held in IDLE for 10 seconds before moving the dynamic brake handle to the SET UP position. This is to eliminate the possibility of a sudden surge of braking effort with possible train run-in or motor flash-over.

THROTTLE HANDLE

The throttle handle, Fig. 2-4, is located just below the dynamic brake handle. It is moved from right to left to increase locomotive power. The handle grip is somewhat out-of-round, with the flattened surfaces horizontal to distinguish it from the dynamic brake handle. The throttle has nine detent positions; IDLE, and 1 through 8 plus a STOP position, which is obtained by pulling the handle outward and moving it to the right beyond IDLE to stop all engines in locomotives coupled in tandem. Mechanical interlocking prevents the throttle handle from being moved out of IDLE into power positions when the dynamic brake handle is advanced to SET UP or beyond, but it can be moved into STOP position to stop all engines. The throttle cannot be moved when the reverser handle is centered and removed from the controller.

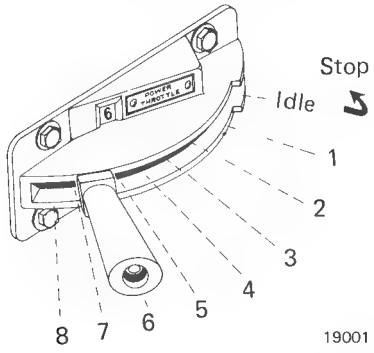


Fig.2-4 – Throttle Handle

REVERSER HANDLE

CAUTION

Damage to the traction motors may occur if the reverser is moved from forward to reverse or from reverse to forward while the locomotive is in motion. Therefore, the reverser direction should be changed only when the locomotive is completely stopped.

The reverser handle, Fig. 2-5, is the lowest handle on the controller panel. It has three detent positions; left, centered, and right. When the handle is moved to the right toward the short hood end of the unit, circuits are set up for the locomotive to move in that direction. When the handle is moved to the left toward the long hood end, the locomotive will move in that direction when power is applied. With the reverser handle centered, mechanical interlocking prevents movement of the dynamic brake handle, but the throttle handle can be moved. In such case, power will not be applied to the traction motors.

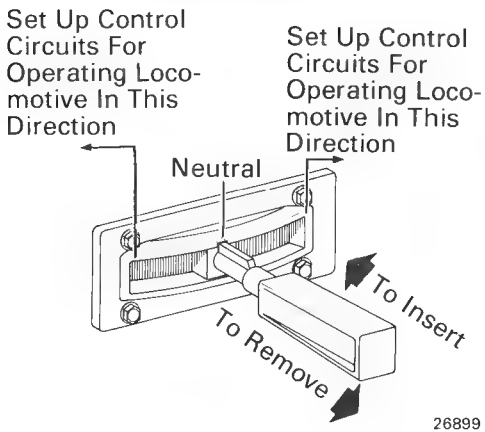


Fig.2-5 – Reverser Handle

The reverser handle is centered and removed from the panel to lock the throttle in IDLE position and the dynamic brake handle in OFF position.

NOTE

Engine speed will be reduced to low idle automatically when the reverser handle is centered, unit is isolated, or whenever the engine run relay is de-energized. However, low idle will be locked out automatically if ambient temperature is low enough to inhibit battery charging.

For standard idle speed, the reverser handle should be in either forward or reverse position, isolation switch in RUN position, and the engine run switch closed (up position).

MECHANICAL INTERLOCKS ON THE CONTROLLER

The handles on the controller are interlocked so that:

1. With reverser handle in neutral (centered)

   a. Dynamic brake handle cannot be moved out of OFF position.

b. Throttle can be moved to any position.

c. Reverser handle can be removed from controller if throttle is in IDLE position.

2. Reverser handle in forward or reverse –

a. Throttle can be moved to any position if dynamic brake handle is in OFF position.

b. Dynamic brake handle can be moved to any position if throttle is in IDLE position.

3. Reverser handle removed from controller –

a. Throttle locked in IDLE position.

b. Dynamic brake handle locked in OFF position.

4. Throttle in IDLE position –

a. Dynamic brake handle can be moved to any position if reverser is in forward or reverse position.

b. Reverser handle can be placed in neutral, forward, or reverse position if dynamic brake handle is in OFF position.

5. Throttle above IDLE position –

a. Dynamic brake handle cannot be moved.

b. Reverser handle cannot be moved.

6. Dynamic brake handle in OFF position

   a. Throttle can be moved to any position.

   b. Reverser handle can be moved to any position if throttle is in IDLE position.

7. Dynamic brake handle moved out of OFF position

   a. Throttle cannot be moved out of IDLE position into power positions, but can be moved into STOP position.

   b. Reverser handle cannot be moved out of forward or reverse into neutral position.

AIR BRAKE EQUIPMENT

Basic locomotives are equipped with type 26L air brake equipment. This equipment is located to the left of the controller and as shown in Fig. 2-6 includes, an automatic brake, independent brake, cut-off pilot valve, a trainline air pressure adjustment valve, and a multiple unit valve (when MU control is installed).

A dead engine feature is also part of the 26L air brake equipment. The dead engine cutout cock and pressure regulator, Fig. 2-7, are accessible from outside the locomotive through side doors provided. The pressure regulator is set by maintenance personnel and is not to be set by the operator.

AUTOMATIC BRAKE VALVE HANDLE

The automatic brake valve handle, Fig. 2-8, controls the application and release of both the locomotive and train brakes. The brake valve is of the "pressure maintaining type" which will hold brake pipe reductions constant against nominal brake pipe leakage. A brief description of the operating positions follows:

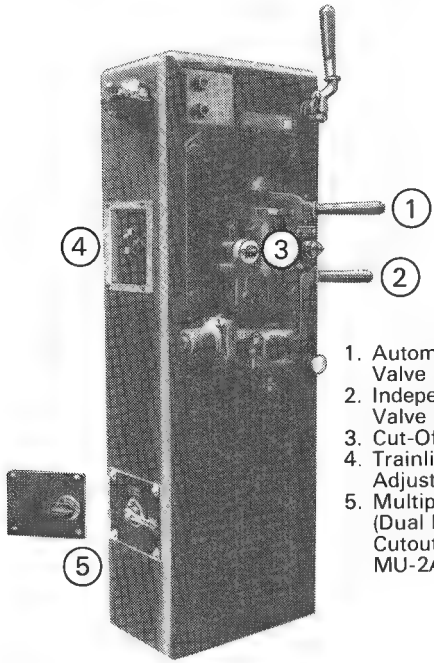


Fig.2-6 – Typical Air Brake Equipment

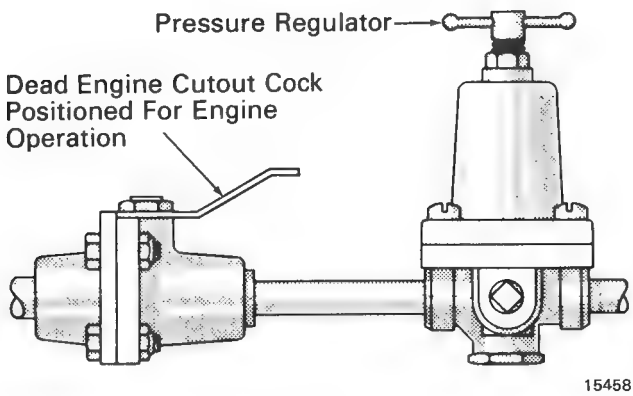


Fig.2-7 – Dead Engine Cutout Cock And Pressure Regulator

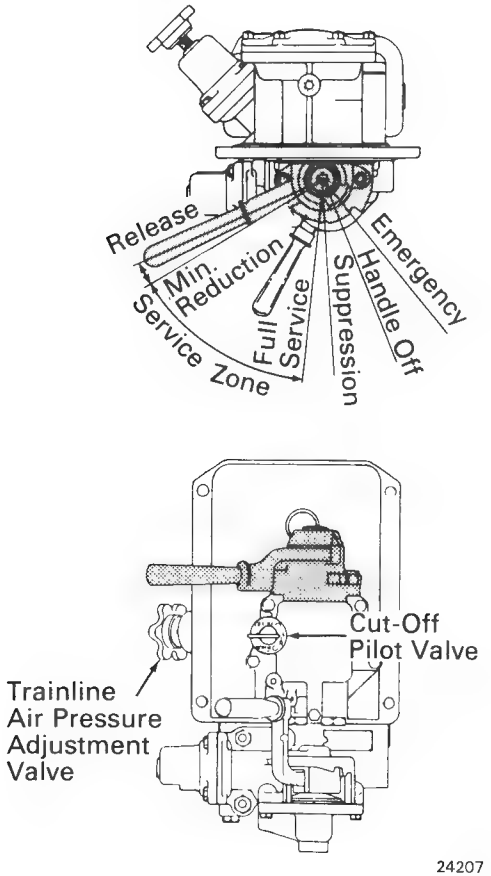


Fig.2-8 – Automatic Brake Handle Positions

Release Position

This position is for charging the equipment and releasing the locomotive and train brakes. It is located with the handle at the extreme left of the quadrant.

Minimum Reduction Position

This position is located with the handle against the first raised portion on the quadrant to the right of release position. With the handle moved to this position, minimum braking effort is obtained.

Service Zone

This position consists of a sector of handle movement to the right of release position. In moving the handle from left to right through the service zone, the degree of braking effort is increased until, with the handle at the extreme right of this sector, the handle is in full service position and full service braking effort is obtained.

Suppression Position

This position is located with the handle against the second raised portion of the quadrant to the right of release position. In addition to providing full service braking effort, as with the handle in full service position, suppression of overspeed control and safety control application, if equipped, is obtained.

Handle Off Position

This position is located by the first quadrant notch to the right of suppression position. If so equipped, the handle is removable in this position. This is the position in which the handle should be placed on trailing units of a multiple-unit locomotive or on locomotives being towed "dead" in a train.

Emergency Position

This position is located to the extreme right of the brake valve quadrant. It is the position that must be used for

making brake valve emergency brake applications and for resetting after a train emergency application.

INDEPENDENT BRAKE VALVE HANDLE

The independent brake valve handle, Fig. 2-9, is located directly below the automatic brake handle.

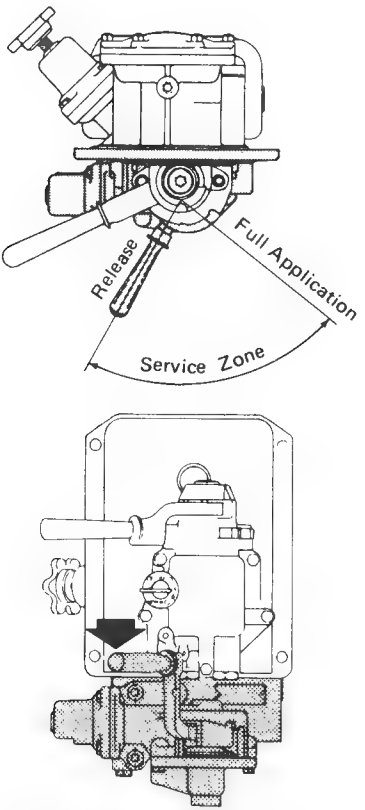


Fig.2-9 – Independent Brake Handle Positions

This handle provides independent control of the locomotive braking effort irrespective of train braking effort. The brake valve is self-lapping and will hold the brakes applied. A brief description of the operating positions follows.

Release Position

This position is located with the handle at the extreme left of the quadrant. This position releases the locomotive brakes, provided the automatic brake handle is also in release position.

Full Application Position

This position is located with the handle at the extreme right of the quadrant. In moving the handle from left to right through the service zone the degree of locomotive braking effort is increased until full application braking effort is obtained.

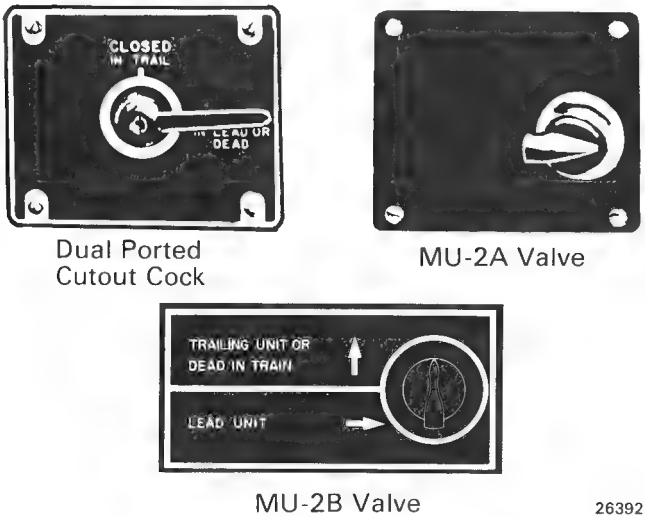
Depression of the independent brake handle whenever the handle is in release position will cause the release of any automatic brake application existing on the locomotive. Depression of the independent brake handle when in the service zone will release the automatic application of the locomotive brakes to the value corresponding to the position of the independent brake handle.

NOTE

This locomotive model can be equipped with either an MU-2A valve, an MU-2B valve, or a dual ported cutout cock for multiple unit control. Information about these devices is provided.

DUAL PORTED CUTOUT COCK

The dual ported cutout cock (if so equipped), Fig. 2-10, is located at the lower left side of the control stand. Its



Dual Ported Cutout Cock

MU-2A Valve

MU-2B Valve

26392

Fig.2-10 – Various Multiple Unit Valves

purpose is to set up the locomotive brake system for lead, trail, or dead operation. The handle is placed in the CLOSED IN TRAIL position when the unit is trailing in a consist, and is placed in the OPEN IN LEAD OR DEAD position when leading or dead.

MULTIPLE UNIT VALVES

MU-2A Valve

The MU-2A multiple unit valve is located on the lower left-hand side of the operator's control stand, Fig. 2-10. Its purpose is to pilot the F1 selector valve which is a device that enables the air brake equipment of one locomotive unit to be controlled by that of another unit.

Three versions of MU-2A multiple unit control are available. In each case the valve is positioned by pushing in and turning to the desired setting.

Basic MU-2A valve applications have the following two positions:

1. LEAD or DEAD

2. TRAIL 26 or 24

Locomotives equipped with three position MU-2A valve applications will utilize one of the following valve position configurations:

Black lettered escutcheon plate

1. LEAD or DEAD

2. TRAIL 6 or 26*

3. TRAIL 24

*Whenever the MU-2 valve is in the TRAIL 6 or 26 position, and if actuating trainline is not used, then the actuating end connection cutout cock must be opened to atmosphere. This is necessary to prevent the inadvertent loss of air brakes due to possible pressure build-up in the actuating line.

Red lettered escutcheon plate

1. LEAD or DEAD

2. TRAIL 6

3. TRAIL 26 or 24

MU-2B Valve

This valve, Fig. 2-10, is located at the side of the control stand. It enables the brake equipment of a trailing unit in a tandem unit locomotive to be correctly controlled by the controlling unit. It has the following two positions: TRAILING UNIT OR DEAD IN TRAIN or LEAD.

CUT-OFF PILOT VALVE

The cut-off pilot valve, Fig. 2-6, is located on the automatic brake valve housing directly beneath the automatic brake handle. The valve has the following two positions:

1. OUT
2. IN

To operate locomotive as the controlling unit, the cut-off valve handle must be pushed in and rotated to the IN position. The OUT position is used when hauling the locomotive "dead" or as a trailing unit coupled in tandem.

On special order the cut-off pilot valve may have the following three positions:

1. OUT
2. FRT (freight)
3. PASS (passenger)

In this case the valve is pushed in and placed in the position desired, depending on make-up of train.

TRAINLINE AIR PRESSURE ADJUSTMENT VALVE

The trainline air pressure adjustment valve, Fig. 2-6, is located to the left of the automatic brake valve. With the automatic brake valve handle in release position, it is used to obtain the brake pipe pressure desired. The automatic brake valve will maintain the selected pressure against overcharge or leakage.

AIR BRAKE EQUIPMENT OPERATING POSITIONS

In the absence of specific instructions, usually issued by each railroad to cover its own recommended practices, refer to Fig. 2-11 for brake equipment operating positions most often encountered while the locomotive is in service.

MISCELLANEOUS CONTROLS AND SWITCHES

The following paragraphs describe miscellaneous controls, switches, and indicators typically provided on the operator's control stand, Fig. 2-1.

AIR HORN VALVE

When the air horn lever is pulled, compressed air is supplied to the locomotive air horn.

SANDING NO. 1 TRUCK TOGGLE SWITCH

The signal from this switch is not trainlined. The switch provides sand to only the number 1 axle of the lead unit of a consist. This method of sanding dresses the rail and is adequate for most conditions. The SAND light will be on when this switch is in the on (up) position.

MANUAL SAND LEVER SWITCH

When operated, this lever supplies a signal to the sanding module. The sanding module determines which direction the locomotive is moving and directs the trainlined signal to the appropriate (forward or reverse) sanding magnet valves. The basic switch is non-latching and may be operated in any direction for correct sanding. A directional sanding switch may be provided as an optional extra, and the switch may be latching if requested by the railroad.

Type Service	Automatic Brake Valve	Independent Brake Valve	Cut-Off Valve	Dead Engine Cutout Cock	26D Control Valve	26F Control Valve	MU Valve	Overspeed Cutout Cock	Deadman Cutout Cock
SINGLE LOCOMOTIVE EQUIPMENT									
Lead	Release	Release	In*	Closed		Graduated Direct	Lead	Open	Open
Shipping Dead In Train	Handle Off Position	Release	Out	Open	Relief Valve At Control Reservoir 503 kPa ± 21 kPa (73 ± 2 psi)	Direct	Dead	Closed	Closed
MULTIPLE LOCOMOTIVE EQUIPMENT AND EXTRAS									
Lead	Release	Release	In*	Closed		Graduated Direct	Lead	Open	Open
Trail	Handle Off Position	Release	Out	Closed		Graduated Direct	Trail	Open	Open
Shipping Dead In Train	Handle Off Position	Release	Out	Open	Relief Valve At Control Reservoir 503 kPa ± 21 kPa (73 ± 2 psi)	Direct Release	Dead	Closed	Closed

*On units equipped with a three position cut-off valve, position valve to either FRT or PASS depending on make-up of train.

27284

Fig.2-11 – Brake Equipment Positions

Electrically controlled sanding is the basic system used, but since the locomotive may be operated in multiple with older units that are equipped only for pneumatic control of sanding, trainlined pneumatic control of sanding may be provided as an optional extra in addition to electrical control. In such cases, trainlined actuating pipes must be connected between units.

BELL RINGER VALVE

This mushroom type valve actuator operates the locomotive signal bell.

GAUGE PANEL

Gauges to indicate various pressures concerned with the air brake system are located at the top of the control stand. The two basic duplex gauges indicate the following:

1. Main Reservoir And Equalizing Reservoir Pressures.
2. Brake Cylinder And Brake Pipe Pressures.

LOAD CURRENT INDICATING METER

Locomotive pulling force is indicated by the load current indicating meter at the upper right portion of the control stand. The meter is graduated to read amperes of electrical current, with 1,500 being the maximum reading on the scale. A red area on the meter face indicates when current levels are too high for continuous operation. Short time rating information on the meter gives the time limitations at various current levels. The times are non-accumulative; that is, considering the conditions under which a locomotive operates it is not necessary to add intermittent periods requiring high current operation. The meter is connected to indicate the current flowing through the No. 2 traction motor. Since the amperage is the same in all motors, each motor will carry the amount shown on the meter.

On special order the meter may be color coded to indicate operating time limits at various meter pointer positions.

On locomotives equipped for dynamic braking, a zero-center type meter is applied, Fig. 2-12. The meter needle swings to the right of zero to indicate load current during power operation, and it swings to the left of zero to indicate dynamic braking current, with 800 amperes being the maximum reading on the braking portion of the meter.

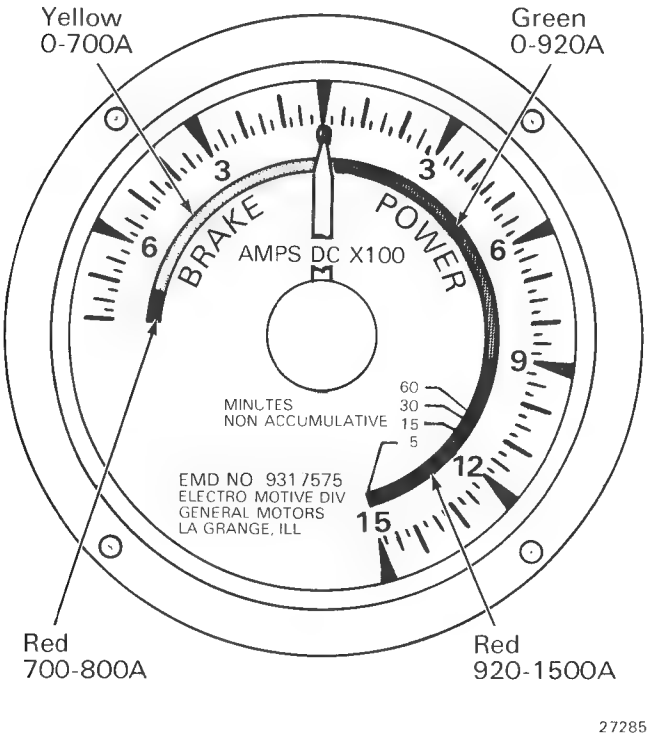


Fig.2-12 – Ammeter When Equipped With Dynamic Brakes

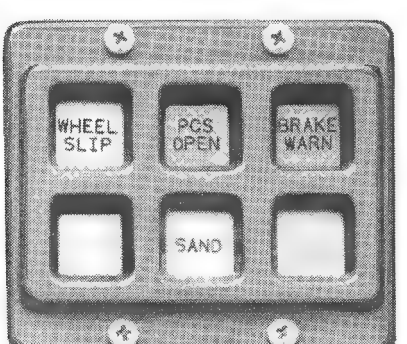
Since the dynamic brake regulator controls maximum braking current, the meter should seldom if ever indicate more than 700 amperes, which is the rating of the dynamic braking resistor grids.

NOTE

The wheel slip control system functions to correct slips by instantaneous reduction of power in small increments and by application of sand. The cumulative effect of a large number of power reductions in rapid succession is to cause the locomotive to maintain power at a level where adhesion can be maintained. Do not misinterpret this loss of power as a defect in the control system.

INDICATING LIGHTS PANEL

This assembly, Fig. 2-13, is located adjacent to the upper left corner of the controller. The purpose of the assembly is to provide a visual warning of operating difficulties. The unit has provisions for six press-to-test lights covered by either white or colored lens caps identified by black block letters.



NOTE

A delay of about 1 second occurs between pressing the indicating lens cap and illumination of the indicator.

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Fig.2-13 – Indicating Lights Panel

The four basic lights installed are wheel slip, PCS open, brake warning, and sand. The functions of these lights are as follows:

Wheel Slip Light

Intermittent flashing of the wheel slip light indicates that the wheel slip control system is doing its job and is correcting the slips. The throttle and locomotive power should not be reduced unless severe lurching threatens to break the train.

WARNING

A wheel slip light flashing persistently or burning continuously may indicate a pair of sliding wheels or circuit difficulty. Stop the locomotive and make a careful inspection to ascertain that there are no locked sliding wheels.

On locomotives equipped with the locked wheel detection system, a continuous wheel slip light accompanied by the alarm indicates a locked wheel. The LOCK WHEEL light on the engine control panel will also be on. Observe the locked wheel indication instruction plate.

PCS Open Light

The PCS or pneumatic control switch functions to automatically reduce locomotive power in the event that an emergency or safety control air brake application occurs. It does so by reducing the speed of ALL engines to idle.

CAUTION

The engine run switch should be in the off (down) position in all trailing units, or (depending on the type and position of locomotives in the consist) it is possible that the PCS switch of the lead unit will not act to reduce engine speeds to idle.

When the switch is tripped, the PCS OPEN light will come on. This light is extinguished and locomotive power restored by resetting the PCS switch. This occurs automatically, provided that:

1. Control of the air brake is recovered.
2. The throttle is returned to IDLE position.

Brake Warn Light (If Provided)

A brake warning light is installed on units equipped with dynamic brakes and functions in conjunction with a brake warning relay. The purpose of the relay and light is to indicate excessive braking current.

In the event that the brake warning light comes on and does not go out quickly, reduce braking handle position immediately to decrease braking strength and prevent possible equipment damage. If the brake warning indication repeats, place the dynamic brake cutout switch on the engine control panel of the affected unit in the CUTOUT position. The unit will then operate normally under power, but not in dynamic braking. Total braking effort of the consist will be reduced.

Sand Light

This light comes on to indicate that the SANDING No. 1 TRUCK switch is closed and that sand is being applied to the No. 1 axle. The light is not affected by the manual, emergency, or wheel slip sanding circuits.

CONTROL AND OPERATING SWITCHES

A group of three operating switches, Fig. 2-14, is located at the upper right corner of the control stand. They snap into the on position when moved upward. The switches must be on in the lead unit of a locomotive consist, and must be off in trailing units.

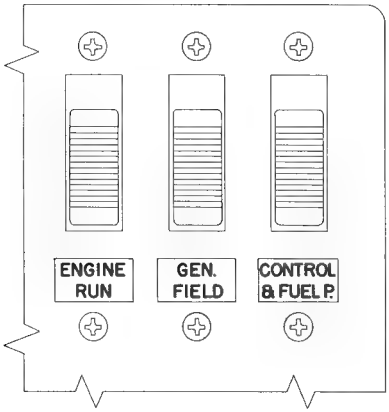


Fig.2-14 – Control And Operating Switches

Engine Run Switch

This switch must be in the on position to obtain throttle control of engine speed. It also provides power to the alarm bell. If the engine run switch is off, the engine will not respond to throttle, and the alarm bell will not operate, except during a low oil pressure or hot engine condition.

Generator Field Switch

The generator field switch must be on to complete excitation circuits to the main generator. If the switch is in the off position, the engine will respond to throttle, but the generator will develop no power.

Control And Fuel Pump Switch

If this switch is off the fuel pump will not operate, and the locomotive will not respond to operating controls. The switch must be on for proper response from the engine start or stop switches.

HEADLIGHT SWITCHES

Two four-position rotary snap switches are provided for independent control of the front and rear headlights. Each switch has OFF, DIM, MED, and BRT positions. All positions of each switch are operative, but in a multiple unit consist, the headlight control switches on the engine control panels of each unit in a consist must be properly positioned, and only the lead unit controls the headlights.

For these switches to function, the headlight circuit breaker must be on.

MISCELLANEOUS SWITCHES

Switches for the ground lights, step lights, and gauge lights are provided at the left side of the controller. The lights are on when the switches are in the up position.

DYNAMIC BRAKE CONTROL CIRCUIT BREAKER (IF PROVIDED)

On locomotives equipped for dynamic braking, this circuit breaker is provided to protect against a faulty operating or test setup. The circuit breaker should be in the on (up) position for normal operation. A tripped circuit breaker generally indicates that at some time during makeup of a locomotive consist more than one dynamic brake handle was out of OFF position at one time.

ATTENDANT CALL PUSHBUTTON

When this button is pressed in any unit of a locomotive consist, the alarm bells ring in all units of the consist.

CAB HEATER SWITCH(ES)

A switch or switches for cab heating equipment at the operator's side of the cab are located on the control stand, Fig. 2-1. The cab heater switch controls the heater and blower. If an auxiliary cab sidewall heater is provided, the auxiliary strip heater switch is located directly above the main heater switch.

HIGH VOLTAGE GROUND/FAULT RESET PUSHBUTTON

The ground relay detects high voltage grounds during operation under power. When it trips, the alarm bells ring in all units in tandem. On the unit affected, generator excitation is lost, the diesel engine goes to idle speed, and the high voltage ground/fault light on the engine control panel comes on.

Available on special order, the ground relay can also be used to detect braking grid grounds that occur during dynamic braking.

To reset the ground relay and restore locomotive power, wait 10 seconds and press the high voltage ground reset pushbutton on the locomotive control stand. It is not necessary to isolate the unit nor is it necessary to place the throttle in idle position before pressing the reset button unless the locomotive is at a standstill.

An automatic ground relay reset assembly can be provided upon special request of the customer. This assembly automatically resets the ground relay circuit within 10 seconds on first, second, and third operation, but locks out the system if a fourth operation occurs within a period of 12 or 15 minutes.

Repeated resetting of the ground relay is permissible, but instructions as issued by the railroad regarding repeated resetting must be followed. However, in the absence of definite instructions to the contrary, isolate a unit when the ground/fault light comes on for the third time after resetting.

CAUTION

Always report high voltage ground/fault light indications to proper maintenance personnel.

SAFETY CONTROL FOOT PEDAL (If So Equipped)

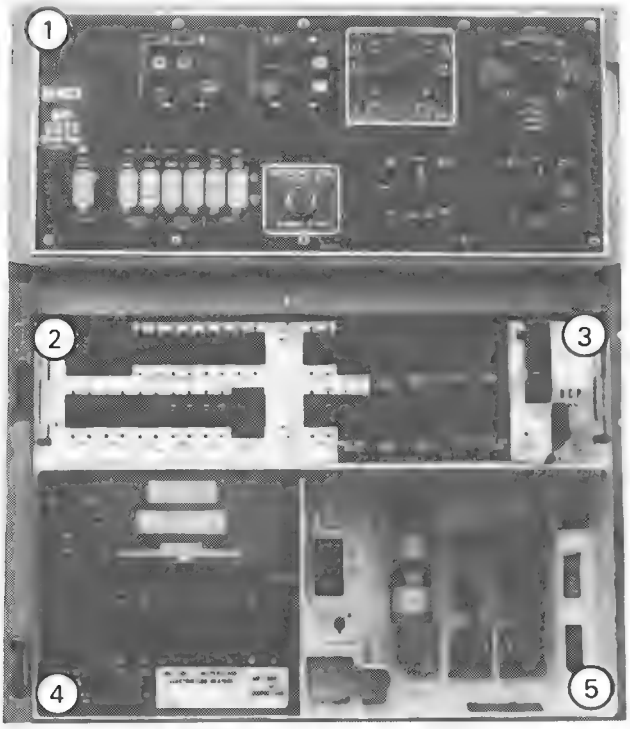
When the safety control pedal is released, a service application of the brakes will occur after a time delay unless there is a specific pressure in the brake cylinders. During the time delay a whistle will sound to alert the operator that a safety control brake application will occur unless the pedal is pressed.

CONTROL CABINET

The control cabinet, Fig. 2-15, contains an engine control panel, a fuse and switch panel, two circuit breaker panels and a circuit breaker compartment. Each of the above contains controls and/or indicating devices used by the operator.

WARNING

Never open any control cabinet doors other than to gain access to the circuit breaker and fuse and switch panels. High voltage and current are present throughout the control cabinet.



1. Engine Control Panel (With Typical Extras)
2. No. 1 Circuit Breaker Panel
3. No. 2 Circuit Breaker Panel
4. Circuit Breaker Compartment
5. Fuse And Switch Panel

27286

Fig.2-15 – GP15T Control Cabinet Panels

ENGINE CONTROL PANEL

The engine control panel, Fig. 2-16, contains various control switches and indicator lights that alert the operator to various operating conditions. Since all of these devices will be used by the operator, a brief description of their functions is provided.

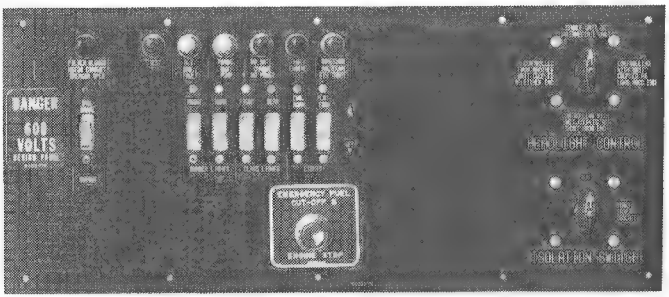


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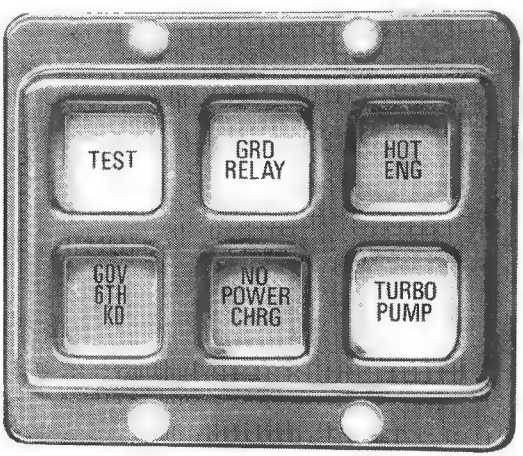
Fig.2-16 – Engine Control Panel, With Typical Extras And Basic Indicating Lights

INDICATOR LIGHTS

Basic locomotives are equipped with indicator lights to alert the operator to various operating conditions. On special order, an indicator light panel, Fig. 2-17, may be substituted for the six basic indicator lights.



25169

Fig.2-17 – No. 1 Indicator Light Panel

Each indicator light panel has provisions for six push-to-test indicator lights. When equipped, a second indicator light panel, Fig. 2-18, will contain one to six additional indicator lights.

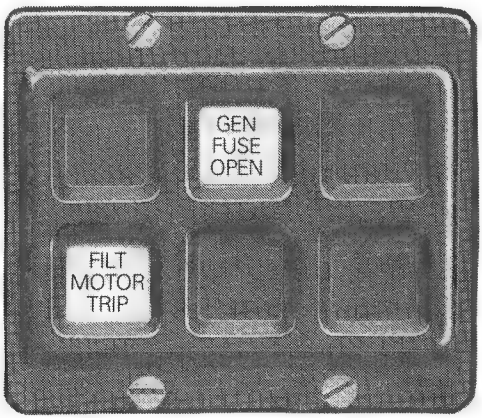


Fig.2-18 – Typical No. 2 Indicator Light Panel

NOTE

Indicator light panels are equipped with push-to-test lights. This feature allows testing of the lamp circuit alone isolated from its operation in the power control system. When the lens cap is depressed, voltage is supplied to the lamp circuit. After a one second delay the light should go on.

NO. 1 INDICATOR LIGHT PANEL

The No. 1 indicator light panel, Fig. 2-17, contains the six basic indicator lights.

TEST Light

The test light comes on when the test panel rotary test switch is placed in the LOAD TEST or CIRCUIT CHECK position. The light indicates that the locomotive circuits are set up for either load testing when the reverser

handle is centered or for circuit check with the generator field circuit breaker open. On special order, the unit can be equipped to automatically load on its own dynamic braking resistor grids. On basic units the generator buses must be connected to an external loading resistor.

CAUTION

Do not perform automatic loading on a unit coupled in tandem or to a train. Do not return test switch to NORMAL position while operating under load.

On basic units the main generator will be open circuited if a load box is not connected during load test setup.

GRD RELAY Light

This light indicates that an electrical path to ground has occurred, or that diodes in the main generator have failed. When the light comes on and the alarm sounds, the operator should wait 10 seconds, then press the ground reset pushbutton located on the control stand. Power will then reapply. It is not necessary to isolate the unit, nor is it necessary to have the throttle in IDLE when pressing the button.

If there is no ground reset button on the control stand, the locomotive will be equipped with special automatic ground relay reset, and the operator need take no action to reset the relay. Such automatic reset devices are equipped for lockout, and automatic reset will be nullified after either a specific number of trips, or after a given number of trips within a time period. On basic locomotives, when the high voltage ground/fault alarm occurs for the third time after being reset twice, the affected unit should be isolated.

CAUTION

Always report ground relay light indications to proper maintenance personnel.

HOT ENG Light

The hot engine alarm light (red) operates in conjunction with the alarm bell to warn the operator that engine cooling water has reached an excessive temperature. Engine speed and power remain normal, but the engine and water system should be checked if the alarm continues. If the light does not go out in a reasonable length of time, shut the engine down.

Upon special request of the customer, a power reduction circuit may be provided. This circuit automatically reduces engine speed and power when a hot engine is detected.

If the cooling system has failed and the engine is allowed to run, a hot lubricating oil detector will dump oil from the low oil pressure detector in the engine governor and bring about engine shutdown. There is no other indication for such a shutdown except a very hot engine condition.

WARNING

When low oil shutdown follows a hot engine warning, and a very hot engine condition is observed, make no further engineroom inspections. Do not attempt to restart the engine. Leave the engineroom area, and report circumstances to authorized maintenance personnel.

NO POWER CHRG Light

Indicates that no AC power is being delivered from the auxiliary alternator to a voltage sensing relay. This may be due to a tripped generator field circuit breaker, engine shutdown, alternator failure, or failure of the DC auxiliary generator which excites the alternator. If the light is on for reasons other than engine shutdown, engine speed and power are reduced to idle conditions.

GOV 6TH KD Light
(Governor Shutdown/6th Throttle Knockdown)

This light comes on for one of the following two reasons:

1. A clogged engine air filter has tripped the EFL relay causing a reduction in engine speed from throttle 8 to throttle 6.

2. The engine governor has shut the engine down due to one of the following causes:

   a. True low oil pressure.

   b. Hot engine oil.

   c. Low cooling water pressure, or any condition which causes the differential pressure across the water pump to drop below airbox pressure.

   d. Crankcase (oil pan) overpressure.

Refer to Safety Devices paragraph under Engineroom Equipment Section for information concerning safety devices.

NO. 2 INDICATOR LIGHT PANEL

The No. 2 indicator light panel contains one to six non basic indicator lights. A typical panel is shown in Fig. 2-18.

FILT MOTOR TRIP Light

When equipped, this light indicates that the carbody inertial filter blower motor is not receiving power. Check for a tripped filter blower motor circuit breaker on the No. 3 circuit breaker panel. If the breaker will not reset, operation may continue to the nearest maintenance point.

GEN FUSE OPEN Light

When equipped, this light indicates a failure within the main generator. Locomotive power may be lost in part or totally, depending on severity of the failure. This automatic function prevents further damage to locomotive systems.

REMOTE TRACTION MOTOR CUTOUT SWITCH

The traction motor cutout switch operates to electrically isolate a defective traction motor. This permits operation with the remaining good motors. The power control system automatically limits power to prevent overloading the operative motors. The isolated motor will continue to rotate as the train moves.

Observe instructions printed on the panel when necessary to cut out a traction motor.

WARNING

Make certain that *all wheels rotate freely* before operating with a motor cut out.

HEADLIGHT CONTROL SWITCH

The twin sealed-beam front and rear headlights are controlled by the front and rear headlight switches on the locomotive control panel. A dimming switch is mounted on the right side of the controller. Before these switches will function, the 35-ampere headlight circuit breaker must be placed on.

On locomotives equipped for multiple unit operation, a remote headlight control switch is mounted on the engine control panel. This remote headlight control switch provides for operation of the rear unit headlight from the lead unit. The switch positions are set on each unit as follows:

ON LEAD UNIT

If only a single locomotive unit is being used, place the switch in SINGLE UNIT position.

In multiple unit service, if trailing units are coupled to the No. 2 or long hood end of the lead unit place the switch in the CONTROLLING-COUPLED AT LONG HOOD END position.

In multiple unit service, if trailing units are coupled to the No. 1 or short hood end of the lead unit, place switch in CONTROLLING - COUPLED AT SHORT HOOD END position.

ON INTERMEDIATE UNITS

On units operating in between other units in a multiple unit consist, place the switch in the SINGLE UNIT position.

ON TRAILING UNITS

The last unit in a multiple unit consist should have the headlight control switch placed on the CONTROLLED-COUPLED AT EITHER END position.

ISOLATION SWITCH

The isolation switch has two positions, one labeled START/STOP/ISOLATE, the other labeled RUN. The functions of these two positions are as follows:

START/STOP/ISOLATE POSITION

The isolation switch is placed in this position whenever the diesel engine is to be started. The start switch is effective only when the isolation switch is in this position.

The START position is also used to isolate the unit, and when isolated the unit will not develop power or respond to the controls. In this event the engine will run at idle

speed regardless of throttle position. This position will also silence the alarm bell in the event of a low lube oil alarm. It will not, however, stop the alarm in the event of a hot engine.

RUN POSITION

After the engine has been started, the unit can be placed on the line by moving the isolation switch to the RUN position. The unit will then respond to control and will develop power in normal operation.

EMERGENCY FUEL CUTOFF AND ENGINE STOP PUSHBUTTON

The switch on the engine control panel is wired in series with emergency fuel cutoff switches located at the fuel filler openings. Pressing any one of the pushbuttons will cause the engine to stop immediately. The switches are spring loaded and do not need to be reset.

The switch operates to stop only the engine in the unit in which the switch is located. In an emergency if it is necessary to stop all engines in a multiple unit consist, pull out on the throttle lever and position it fully to the right.

DYN. BRAKE CUTOUT SWITCH (If Provided)

On units so equipped, when this switch is placed in the CUTOUT position, the individual unit will not operate in dynamic braking. It will however, continue to operate normally under power. The switch can be used to limit the number of units in a consist that will operate in dynamic braking, or it may be used to cut out a unit that is defective in dynamic braking, yet allow it to operate under power.

MISCELLANEOUS SWITCHES

Switches are included in circuits for various lights and devices in the locomotive. The switches are closed as desired to operate the class lights, the number lights, and the platform lights.

CIRCUIT BREAKERS

There are two circuit breaker panels and a circuit breaker compartment on the electrical control cabinet. They contain circuit breakers and controls used to protect engine, control systems, lights, and miscellaneous devices that are used as conditions require. The circuit breakers can be operated as switches, but will trip open when an overload occurs.

NO. 1 CIRCUIT BREAKER PANEL

This panel contains circuit breakers that protect customer requested extras. The No. 1 circuit breaker panel, Fig. 2-19, has provisions for 12 circuit breakers.

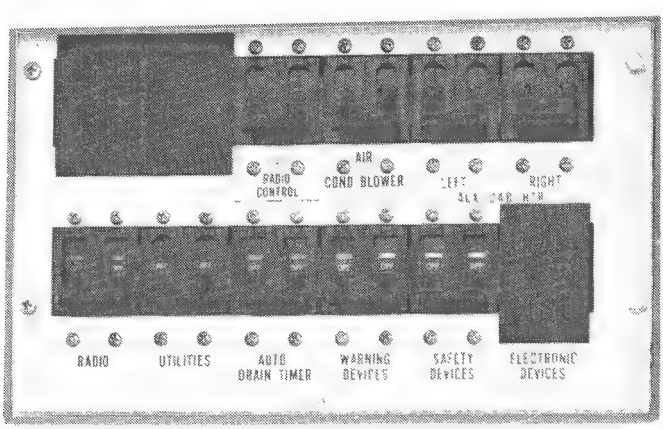


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Fig.2-19 – Typical No. 1 Circuit Breaker Panel

The following paragraphs contain a brief description of typical circuit systems protected by breakers on this panel.

RADIO CONTROL

When equipped for remote radio control this breaker protects radio control circuits.

AIR COND. BLOWER

When equipped with air conditioning this breaker protects the blower fan motor circuits. A separate breaker for the air conditioner compressor is located on No. 3 circuit breaker panel.

AUX. CAB HTR.

These breakers protect the left and right auxiliary cab heaters. Heat control is provided by switches located at each heater.

RADIO

Protects circuits that supply the radio, when equipped.

UTILITIES

When equipped, this breaker protects the toilet immersion heater, or similar devices.

AUTO. DRAIN TIMER

Protects circuits that control automatic operation of drain valves in the compressed air system.

WARNING DEVICES

This breaker protects signal light circuits, when equipped. This breaker may also be used to protect similar devices.

SAFETY DEVICES

Train overspeed brings about a penalty application of the brakes and operation of the pneumatic control switch to drop locomotive power. This breaker protects the overspeed magnet valve circuit. This breaker may also be used to protect similar devices.

NO. 2 CIRCUIT BREAKER PANEL

The No. 2 circuit breaker panel, Fig. 2-20, contains circuit breakers and switches that protect basic locomotive equipment and control systems. The panel is divided into three sections. The shaded middle section indicates breakers required on for locomotive operation. Breakers in the unshaded section are used as conditions require.

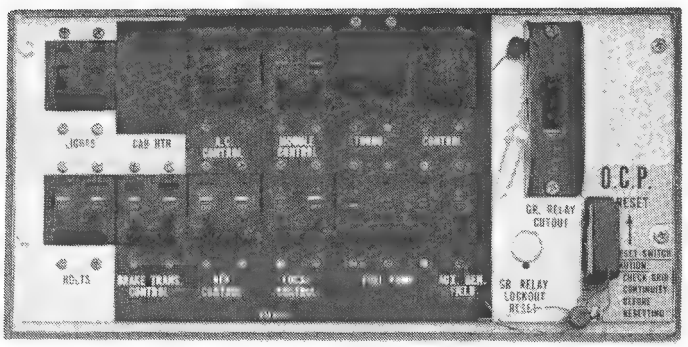

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Fig.2-20 – No. 2 Circuit Breaker Panel

BREAKERS REQUIRED ON FOR LOCOMOTIVE OPERATION

AC CONTROL

This breaker protects the portion of the sensor module receiving AC power from the companion alternator. The sensor module controls main generator field excitation current level. The no AC voltage relay (NVR) is also connected in this circuit. If the breaker trips during locomotive operation, the main generator will not develop power and the no power/charge light on the engine control panel will come on indicating no companion alternator output.

MODULE CONTROL

This breaker protects the local control circuit that supplies power to the circuit modules and miscellaneous control system devices.

TURBO

This breaker must be in the on position to start the engine and operate the turbocharger auxiliary lube oil pump. It must remain in the on position to provide auxiliary lubrication to the turbocharger at engine start and after the engine is shut down.

CONTROL

This breaker sets up the fuel pump and control circuits for engine starting. Once the engine is running, power is supplied through this breaker from the auxiliary generator to maintain operating control.

BRAKE TRANS. CONTROL

This double pole breaker is located in the feed to the operating motor of the multi-pole, motor operated, ganged switches that control the motor field and armature connections for either dynamic braking or power operation. Since control power is required to move the transfer switchgear from any position to any other position, the breaker must be closed for power transfer to take place. An open breaker does not prevent switchgear from already being in position to properly conduct motor or braking current, but interlocking prevents an operating setup in conflict with transfer switch position.

REV. CONTROL

This breaker is located in the feed to the operating motor of the multi-pole, motor operated, ganged switches that control the direction of current flow through the traction motor fields and thus control the direction of locomotive travel. Since control power is required to move the RV transfer switchgear from any position to any other position, this breaker must be closed for power transfer to take place. An open breaker does not prevent switchgear from already being in position to properly conduct traction motor current, but interlocking prevents an operating setup in conflict with transfer switch position.

LOCAL CONTROL

This circuit breaker establishes "local" power from the auxiliary generator to operate heavy duty switchgear and various control devices.

FUEL PUMP

This breaker protects the fuel pump motor circuit. A fuel filter bypass valve is provided to prevent overloading the fuel pump motor if the fuel filter becomes clogged.

AUX. GEN. FIELD

The field excitation circuit of the auxiliary generator is protected by this breaker. In the event that this breaker trips it stops auxiliary generator output to the low voltage system and also stops fuel pump operation. An alternator failure (no power no battery charge) alarm occurs. The engine will stop from lack of fuel.

MISCELLANEOUS CIRCUIT BREAKERS

LIGHTS

This breaker must be on to supply power to switches that control miscellaneous locomotive lights.

CAB HTR.

These breakers provide protection for electrical cab heaters, when applied.

HDLTS.

This breaker must be on to provide current to the front headlight circuit and through the trainline to the light at the rear of the consist.

GROUND RELAY CUTOUT SWITCH

The purpose of the ground relay cutout switch is to eliminate the ground protective relay from the locomotive circuits during certain shop maintenance inspections. It must always be kept closed in normal operation. When

this switch is open, it prevents excitation of the main generator and speedup of the diesel engine in addition to cutting out the ground protective relay.

OPEN GRID CIRCUIT RESET

This button is used to reset the open grid circuit protective relay (OCP) on units equipped with extended range dynamic braking. If an open circuit occurs in the dynamic braking grids or cabling the OCP relay will pickup, locking out dynamic braking.

CAUTION

Do not reset the OCP relay. The OCP relay should only be reset by maintenance personnel following a thorough inspection of the dynamic brake grids and cabling.

CIRCUIT BREAKER COMPARTMENT

The circuit breaker compartment, Fig. 2-21, has provisions for five circuit breakers. The panel also contains a sealed section. This section contains a test panel intended for use by maintenance personnel during maintenance and testing procedures. A 74 volt receptacle and fuse test switch are also part of this panel.

The circuit breaker portion of the panel is divided into two sections. Breakers in the shaded section are required on for locomotive operation. Breakers in the unshaded section are to be used as conditions require.

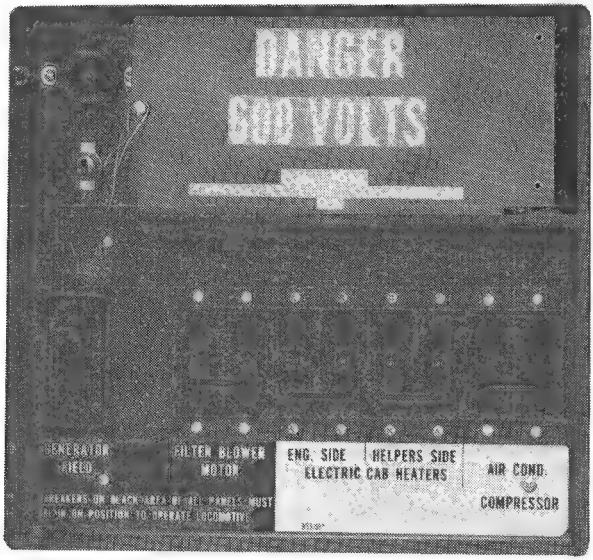

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Fig.2-21 – Circuit Breaker Compartment (With Typical Extras)

BREAKERS REQUIRED ON FOR LOCOMOTIVE OPERATION

GENERATOR FIELD

The main generator receives excitation current through a controlled rectifier from the companion alternator. This breaker is provided to protect the controlled rectifier and both generators as well as associated circuitry.

NOTE

Unlike other breakers on the panel that trip to the full off position, the generator field circuit breaker will trip to the center position. After a period for cooling, the breaker must be placed in full off position before resetting to the on position.

FILTER BLOWER MOTOR

This breaker protects the inertial filter blower motor circuit. The blower is used to evacuate dirt loaded air from the central air compartment inertial filters.

When equipped, the FILT. MOTOR TRIP light on the engine control panel will come on if this breaker trips open or is inadvertantly left in the off position. If tripped open, operation may continue to the nearest maintenance point.

MISCELLANEOUS CIRCUIT BREAKERS

ELECTRIC CAB HEATERS

Eng. Side

Protects circuits to the cab heater at the engineer's station.

Helpers Side

Protects circuits to the cab heater at the helper's side of the cab.

AIR COND. COMP.

When equipped with air conditioning, this breaker protects the air compressor circuits. A separate breaker for the air conditioner blower fan motor is located on the No. 1 circuit breaker panel.

FUSE TEST SWITCH

Refer to Fuse Test Equipment paragraph under the Fuse And Switch Panel section.

74 VOLT RECEPTACLE

This receptacle makes 74 volts DC available for maintenance or testing purposes. Power is supplied to the receptacle when the main battery switch and the LIGHTS circuit breaker are closed.

FUSE AND SWITCH PANEL

The fuse and switch panel, Fig. 2-22, contains the equipment described in the following paragraphs.

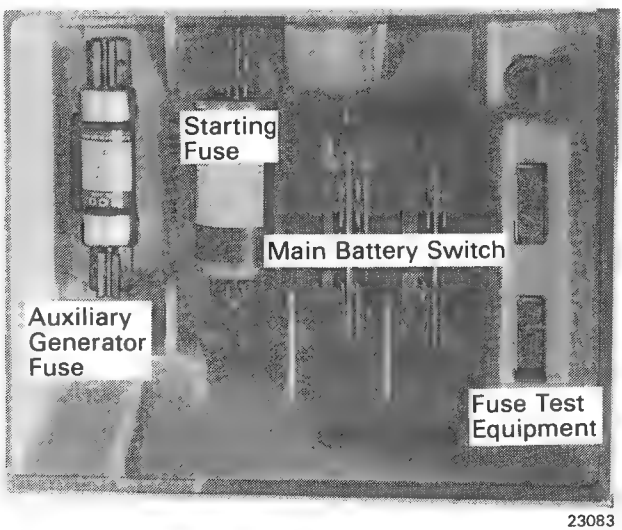


Fig.2-22 – Fuse And Switch Panel

NOTE

There is no companion alternator field fuse. If a short occurs in this circuit, auxiliary generator voltage will come down, and the machine will not be harmed. A no power/no battery charge alarm occurs.

AUXILIARY GENERATOR FUSE

This fuse connects the auxiliary generator to the low voltage system. It protects against excessive current demands. A 150 ampere fuse is installed for the basic auxiliary generator. In the event that the fuse is burned out, it stops auxiliary generator output to the low voltage

system and also stops fuel pump operation. An alternator failure (no batt. charge/no power) alarm would then occur. The engine will go to idle speed and then stop from lack of fuel.

AUXILIARY GENERATOR Circuit Breaker (If So Equipped)

This breaker performs the same function as fuse (above). However, unlike other breakers on the panel that trip to the full off position, this breaker will trip to the center position. After a period for cooling, the breaker must be placed in the full off position before resetting to the on position.

STARTING FUSE

The starting fuse is in use only during the period that the diesel engine is actually being started. At this time, battery current flows through the fuse and starting contactor to the starting motor.

Although this fuse should be in good condition and always left in place, it has no effect on locomotive operation other than for engine starting. A defective fuse can be detected when attempting to start the engine, since at that time (even though the starting contacts close) the starting circuit is open.

CAUTION

Observe fuse panel marking. Do not use an incorrectly rated starting fuse.

MAIN BATTERY KNIFE SWITCH

This switch is used to connect the batteries to the locomotive low voltage electrical system and should be kept closed at all times during operation.

The main battery knife switch may be opened during certain shop maintenance procedures and in instances where the engine is shut down and the locomotive taken out of service for an extended layover. This will prevent the battery from being discharged in the event the lights or other low voltage devices are inadvertently left operating during the layover.

CAUTION

Do not open battery switch at engine shutdown following load operation. The turbocharger lube oil pump will come on and continue to run for approximately 35 minutes following engine shutdown, then shut off automatically. The 35 minutes allows turbocharger bearings to cool using engine lube oil.

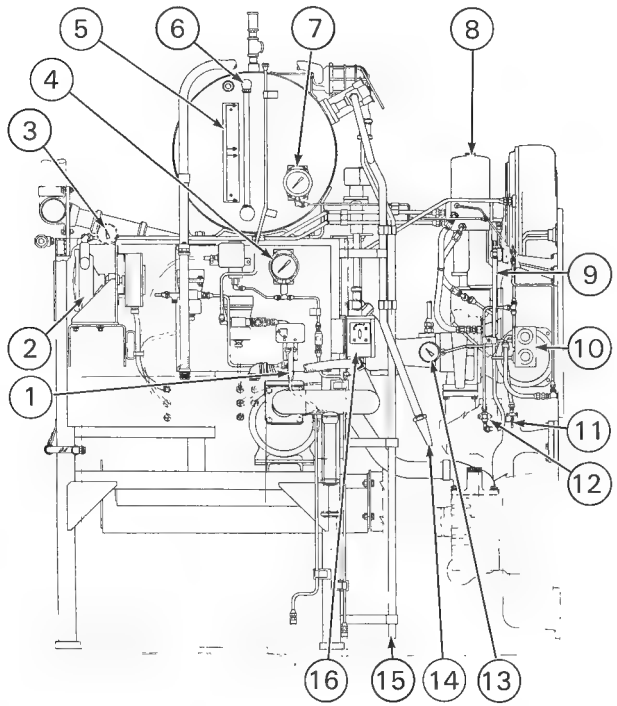
FUSE TEST EQUIPMENT

To facilitate testing of fuses, a pair of fuse test blocks and a test light are installed on the fuse and switch panel. A test light toggle switch is located on the circuit breaker panel. Fuses may be readily tested as follows. Move test light switch to the on position to make sure the fuse test light is not burned out. Move test light switch to the off position to turn light off. Place fuse to be tested across the test blocks so that the metal ends of the fuse are in firm contact with the blocks. If the fuse is good the light will come on.

It is always advisable to test fuses before installation. Always isolate the circuits in question by opening their switches before changing or replacing fuses.

ENGINEROOM EQUIPMENT

Engine starting and monitoring equipment is located in the engineroom as shown in Fig. 2-23.



1. Manual Shutter Control Valve
2. Load Regulator
3. Fuel Oil Filter Bypass Gauge
4. Main Reservoir Air Pressure Gauge
5. Water Level Instruction Plate
6. Water Level Sight Gauge
7. Lube Oil Pressure Gauge
8. Governor (See Fig. 2-25)
9. Injector Control Lever (Layshaft)
10. Low Water And Crankcase Pressure Detector (See Fig. 2-26)
11. Test Cock
12. Hot Oil Detector
13. Water Temperature Gauge
14. Water Filler
15. Water Tank Overflow
16. Fuel Prime/Engine Start Switch (See Fig. 2-24)

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Fig.2-23 – Engineroom Equipment

ENGINE STARTING CONTROLS

NOTE

Refer to Operation section for complete inspection and starting instructions.

FUEL PRIME/ENGINE START SWITCH

This three position rotary switch, Fig. 2-24, is located in a junction box mounted on the equipment rack. The functions of the three positions are as follows:

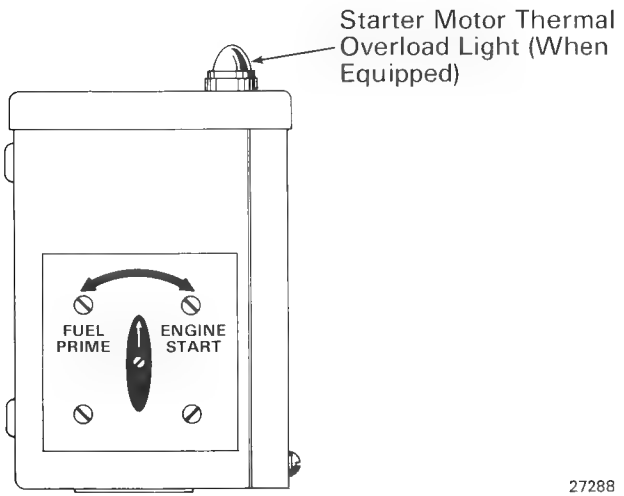


Fig.2-24 – Fuel Prime/Engine Start (FP/ES) Switch

1. FUEL PRIME Position – This position is used to prime the engine with fuel prior to starting. In this position the fuel pump motor is energized with battery power but the engine will not crank. Additional contacts energize the auxiliary turbocharger lube oil pump motor, ensuring a supply of lube oil under pressure to the turbocharger bearings during startup.

2. ENGINE START Position This position is used to supply power from the batteries to the starting motors. The starter motor pinion gear engages with the engine ring gear which causes the engine to crank until FP/ES switch is released.

3. Centered (Off) Position The FP/ES switch is spring loaded to return to this position when released. Contacts that are normally closed in this position supply power to the fuel pump motor from the auxiliary generator when the engine is running.

NOTE

When equipped, a light on top of the FP/ES switch junction box will come on to indicate that the starter motors have been overloaded. When this light is on, power will not be applied to the starter motors regardless of FP/ES switch position. The light will go out automatically when starter motors have cooled sufficiently to allow restart attempt.

INJECTOR RACK MANUAL CONTROL LEVER (LAYSHAFT)

This engine mounted hand operated lever, Fig. 2-23, may be used to manually operate the injector racks. It is primarily used to position the injector racks during engine cranking, thereby providing an immediate supply of fuel to the cylinders.

CAUTION

On units equipped with engine purge control system, do not push injector control lever until engine has cranked for 6 seconds.

MONITORING DEVICES

The following devices monitor certain locomotive systems. They provide visual indication as to the condition of the systems.

Each device represents a system which could cause the engine to shut down. Periodic checks of these systems will alert the operator to an impending failure. Report all abnormal readings to proper maintenance personnel.

WATER LEVEL INSTRUCTION PLATE

This plate is mounted next to a sight gauge on the water tank. To check water level, open round valve handle at bottom of gauge. Read water level using the instruction plate as a guide, then close valve. To avoid false readings drain gauge using small drain cock at bottom of gauge.

LUBE OIL PRESSURE GAUGE

This gauge provides a ready reference indicating lube oil pressure. During normal operation lube oil pressure will increase as diesel engine speed increases.

WATER TEMPERATURE GAUGE

Engine inlet water temperature may be readily checked using this gauge. The gauge is color coded to indicate COLD (blue), NORMAL (green), and HOT (red). Temperature approaching the hot zone may indicate tunnel or similar operation.

AIR PRESSURE GAUGE

This gauge indicates No. 1 main air reservoir pressure.

FILTER BYPASS GAUGE

This gauge indicates condition of the primary fuel filter. Increased pressure differential across the filter will be indicated by a higher reading on the gauge. As the pressure increases a bypass valve will begin to open, bypassing the primary fuel oil filter. This bypassing imposes a filtering burden on the engine mounted fuel oil filters which will shorten their service life.

SAFETY DEVICES

A mechanism to detect low engine lubricating oil pressure is built into the engine governor. Under normal operating conditions engine lubricating oil, under pressure, is supplied to the mechanism. Should oil pressure drop to a dangerously low level, a small plunger, Fig. 2-25, will pop out the side of the governor body, indicating that the mechanism has tripped. The GOVERNOR SHUTDOWN light will come on and the engine will shut down in approximately 2 seconds if operating in throttle positions 4 and above. At idle and throttle positions, 1, 2, and 3, a time delay before shutdown, is built into the governor.

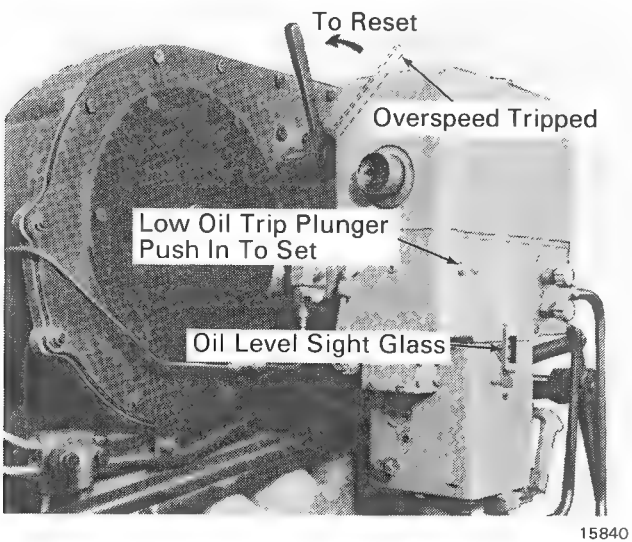


Fig.2-25 – Governor Low Oil Trip Plunger And Engine Overspeed Trip Reset Lever

The locomotive is also equipped with devices, Fig. 2-26, which will detect low cooling water pressure, and excessive crankcase pressure. When activated, the devices release oil pressure from the line leading to the low oil pressure mechanism in the governor, causing engine shutdown.

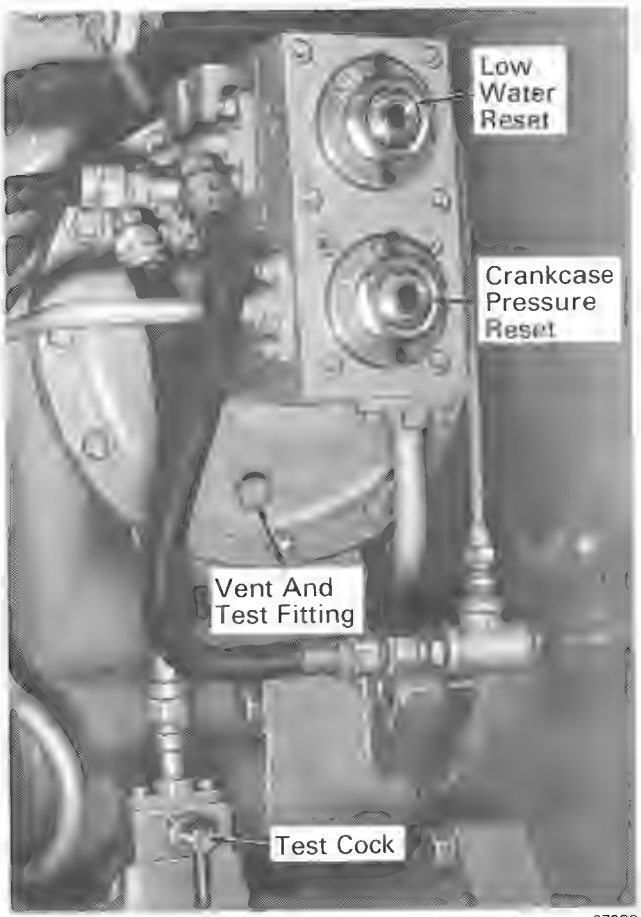


Fig.2-26 – Differential Low Water And Crankcase (Oil Pan) Pressure Detector

If necessary to determine cause of shutdown, check the crankcase pressure and differential low water pressure detecting devices for protruding reset buttons. A protruding button indicates the device that has caused engine shutdown. If crankcase pressure or low water pressure are not the cause, then the engine was shut down by either the hot oil detector or a true oil pressure failure.

WARNING

When it is determined that the crankcase pressure detector has tripped, make no further engineroom inspections. Do not attempt to restart the engine. Isolate the unit. Drain the cooling system in accordance with railroad regulations if freezing conditions are possible.

If neither the crankcase pressure nor the low water pressure detector has tripped, and engine oil level is satisfactory with a hot engine condition apparent, do not attempt to restart the engine. Report engine shutdown circumstances to maintenance personnel.

OVERSPEED MECHANISM

An overspeed mechanism is provided to stop injection of fuel into the cylinders should engine speed become excessive. This will result in immediate shutdown of the engine and a no power/no battery charge alarm.

To reset mechanism, move trip reset lever, Fig. 2-25, counterclockwise until it resets.

MISCELLANEOUS DEVICES

MANUAL SHUTTER CONTROL VALVE

During normal operation this valve is in the OPERATION position. In this position the cooling control system automatically opens and closes the cooling system shutters, depending on conditions.

In any emergency, the shutters may be opened manually by moving the shutter control valve to the TEST position.

SECTION 3
OPERATION

INTRODUCTION

This section covers recommended procedures for operation of the locomotive. The procedures are briefly outlined and do not contain detailed explanation of equipment location or function.

PREPARATION FOR SERVICE

GROUND INSPECTION

Check for the following:

1. Leakage of fuel oil, lube oil, water, or air.
2. Loose or dragging parts.
3. Proper hose connections between units in multiple.
4. Proper positioning of all angle cocks and shut-off valves.
5. Air cut in to truck brake cylinders.
6. Satisfactory condition of brake shoes.
7. Fuel supply.
8. Proper installation of control cables between units.

LEAD UNIT CAB INSPECTION

On the lead or control unit, the control locations described in Section 2 should be checked and the equipment positioned for operation as follows:

FUSE AND SWITCH PANEL

1. Main battery switch closed.
2. All fuses installed and in good condition, and of correct rating as indicated on panel.

CIRCUIT BREAKER PANELS AND CIRCUIT BREAKER COMPARTMENT

1. All breakers in the black area of the panels in on position.
2. Other circuit breakers on as required.
3. At the No. 2 circuit breaker panel, verify that the ground relay cutout switch is closed.

ENGINE CONTROL PANEL

1. Isolation switch in START position.
2. Headlight control switch in proper position for lead unit operation.
3. Miscellaneous switches positioned as required.
4. Remote traction motor cutout switch (if so equipped), in MOTORS ALL IN position.
5. Dynamic brake cutout switch (if so equipped) in DYN. BRAKE (up) position.

NOTE

The electrical cabinet is pressurized with filtered air. Cabinet doors must be securely closed during locomotive operation.

OPERATOR'S CONTROL STAND

Switches and operating handles on the control stand should be positioned as follows:

1. Place control and fuel pump switch in on (up) position.

2. Place engine run switch and the generator field switches in the off (down) position.

3. Light and miscellaneous switches positioned as desired.

4. Move throttle handle to IDLE and dynamic brake handle to OFF position. Position reverser handle to neutral and remove.

AIR BRAKE EQUIPMENT

1. Insert automatic brake valve handle (if removed) and place in SUPPRESSION position. This will nullify the application of any safety control equipment used.

2. Insert independent brake valve handle (if removed) and move to FULL APPLICATION position.

3. Position cut-off pilot valve to IN position. On units equipped with a three position cut-off valve, position valve to either FRT or PASS depending on make-up of train.

4. Place multiple unit valve in lead position.

STARTING THE DIESEL ENGINE

After the following inspections have been completed, the diesel engine may be started.

ENGINEROOM INSPECTION

The engineroom equipment can be inspected and operated by opening the access doors along the sides of the locomotive long hood.

1. Check air compressor for proper lube oil supply.

2. Check that water level, in water tank sight glass, is near the FULL (ENGINE DEAD) mark on the water level instruction plate.

NOTE

Water level should be rechecked when engine is running. Level should be near FULL (ENGINE RUNNING) mark.

3. Check all valves for proper positioning.

4. Observe for leakage of fuel oil, lube oil, water, or air.

ENGINE INSPECTION

The engine should be inspected before as well as after starting.

1. Check that overspeed mechanism is set.

2. Check that the governor low oil pressure trip plunger is set, and that oil is visible in the governor sight glass.

3. Check that the crankcase (oil pan) pressure and low water pressure detector reset buttons are set (pressed in). If either button protrudes, press and hold button for 5 seconds immediately after engine starts.

4. Check that engine top deck, air box and oil pan inspection covers are in place and are securely closed.

5. Check sight gauge on lube oil filter tank. If gauge is full, proceed to Step 6. If gauge is empty, make certain that oil strainer housing is full. The oil level should be maintained up to the overflow outlet of the housing.

6. Pull out oil level gauge (dipstick) from side of engine oil pan. Oil gauge should be coated with lube oil.

NOTE

A properly filled lube oil system will coat the oil gauge above the FULL mark when the engine is stopped. To obtain an accurate check, recheck level, when the engine is idling and at normal operating temperature.

ENGINE STARTING

After the preceding inspections have been completed, the diesel engine may be started. Close engineroom doors after engine start.

Perform the following:

NOTE

If engine temperature is near freezing, preheat engine before attempting to start. Prelube engine if it has been shut down more than 48 hours. Refer to Engine Maintenance Manual for prelube procedures.

1. Open cylinder test valves and bar over the engine at least one revolution. Observe for leakage from test cocks. Close test cocks.

NOTE

Leakage from cylinder test valves indicates a problem within the engine. Notify maintenance personnel.

2. Check that all fuses are installed and in good condition, and of the correct rating as indicated on panel. Verify that the main battery and ground relay cutout switches are closed.

3. At the circuit breaker panels and circuit breaker compartment, check that all breakers in the black areas are in the on position.

4. At the operator's control stand, make certain that the generator field and engine run switches are off (down). Verify that the control and fuel pump switch is on (up).

NOTE

When starting trailing unit diesel engines and control cables have been connected between units, the control and fuel pump switch should remain off.

5. At the engine control panel, verify that the isolation switch is in the START position.

6. At the equipment rack, place the fuel prime/engine start switch in the FUEL PRIME position until fuel flows in the return fuel sight glass, Fig. 3-1, clear and free of bubbles (normally 10 to 15 seconds).

CAUTION

On units equipped with engine purge control system, do not push injector control lever until engine has cranked for 6 seconds.

7. Position injector control lever (layshaft) at about one-third rack (about 1.6 on the governor scale), except units equipped with engine purge control system. Move the fuel prime/engine start switch to ENGINE START position. Hold the switch in this position until the engine fires and speed increases, but not more than 20 seconds.

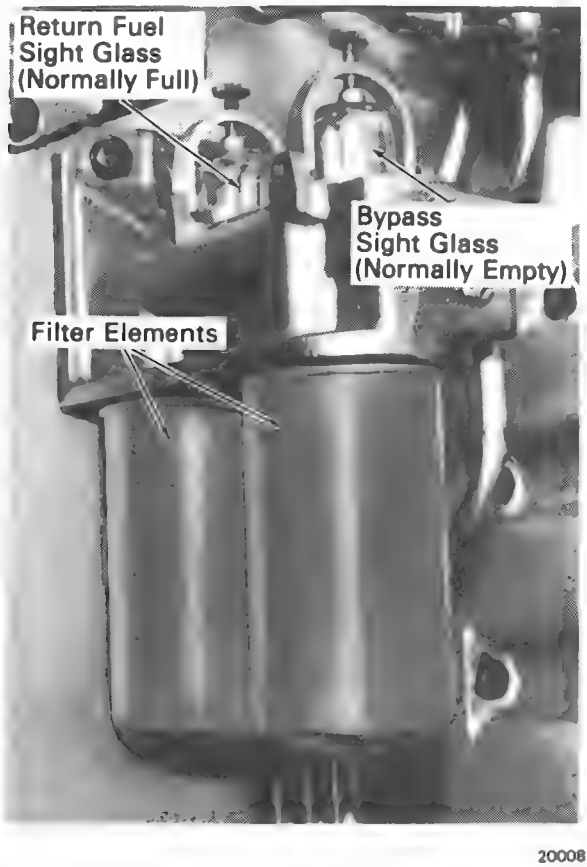


Fig.3-1 – Fuel Oil Sight Glasses

CAUTION

Starter motors should not be allowed to crank engine for more than 20 seconds. If engine fails to start after 20 seconds have elapsed, allow 2 minutes for starter cooling.

8. Release injector control lever when engine comes up to idle speed. Do not advance lever to increase speed until oil pressure is confirmed.

NOTE

Engine water inlet temperature should be allowed to reach 49° C (120° F) before load is applied. After idling in extremely cold weather, increase to full load should be made gradually.

9. Check low water pressure detector reset button after engine starts. If tripped, press button to reset detector. The engine will shut down after a short time delay if the detector is not reset.

NOTE

If the detector is difficult to reset after engine starts, confirm oil pressure, then position the injector control lever (layshaft) to increase engine speed for a short time, and press the reset button.

10. Check the following with the engine running and at normal operating temperature.

    a. Coolant level is near the FULL (ENGINE RUNNING) mark on the water level instruction plate.

    b. Lube oil level is near the FULL mark on oil level gauge (dipstick).

    c. Governor oil level.

    d. Compressor lube oil level.

TRAILING UNIT CAB INSPECTION

Switches, circuit breakers, and controls located in the cab of a trailing unit should be checked for proper positioning as follows:

FUSE AND SWITCH PANEL

1. Main battery knife switch closed.

2. Fuses installed and in good condition, and of correct rating as indicated on panel.

CIRCUIT BREAKER PANELS AND CIRCUIT BREAKER COMPARTMENT

1. All breakers in the black area of the circuit breaker panels and circuit breaker compartment in on position.

2. Other circuit breakers on as required.

3. At the No. 2 circuit breaker panel, verify that the ground relay cutout switch is closed.

ENGINE CONTROL PANEL

1. Isolation switch in START position.

2. Headlight switch in proper position to correspond with units position when connected in tandem.

3. Miscellaneous switches positioned as required.

4. Remote traction motor cutout switch (if equipped), in MOTORS ALL IN position.

NOTE

The electrical cabinet is pressurized with filtered air. Cabinet doors must be securely closed during locomotive operation.

OPERATOR'S CONTROL STAND

Switches and operating handles on the control stand should be positioned as follows:

1. Control and fuel pump switch, generator field switch, and engine run switch must be off.

2. Move throttle to IDLE and dynamic brake handle to OFF position. Position reverser handle to neutral and remove to lock other handles.

3. Light and miscellaneous switches positioned as desired.

AIR BRAKE EQUIPMENT

1. Place automatic brake valve handle in HANDLE OFF position. Remove handle (if so equipped).

2. Place independent brake valve handle in RELEASE position. Remove handle (if so equipped).

3. Place cut-off pilot valve to OUT position.

4. Place multiple unit valve in a trailing unit position.

STARTING TRAILING UNIT DIESEL ENGINES

Engines in trailing units are started in the same manner as the engine in the lead unit. Refer to "Starting The Diesel Engine" portion of this section.

NOTE

If control jumper cables are already connected between units, ensure that the control and fuel pump, generator field, and engine run switches are off. This will allow these systems to be controlled from the lead unit.

PLACING UNITS ON THE LINE

After the diesel engines are started and inspected, units may be placed on the line as desired by placing the isolation switch on the engine control panel in the cab in the RUN position. If units connected in tandem are at a standstill, be certain that the throttle handle in all units is in the IDLE position before placing any unit on the line.

PRECAUTIONS BEFORE MOVING LOCOMOTIVE

The following points should be carefully checked before attempting to move the locomotive under its own power.

1. Make sure that main reservoir air pressure is normal.

   This is very important, since the locomotive is equipped with electro-magnetic switchgear which will function in response to control and permit operation without air pressure for brakes.

2. Check for proper application and release of air brakes.

3. Release hand brake and remove any blocking under the wheels.

CAUTION

It is desirable that engine water temperatures be 49° C (120° F) or higher before full load is applied to the engine. After idling at ambient temperature below -18° C (0° F), increase to full load level should be made gradually.

HANDLING LIGHT LOCOMOTIVE

With the engine started and placed "on-the-line" and the preceding inspections and precautions completed, the locomotive is handled as follows:

1. Place the engine run switch and generator field switch in on (up) position.

2. Place headlight and other lights on as needed.

3. Insert reverser handle and move it to the desired direction of travel, either forward or reverse.

4. Depress safety control foot pedal (if so equipped).

5. Release air brakes.

6. Open throttle to position No. 1, 2, or 3 as needed to move locomotive at desired speed.

NOTE

Locomotive response to throttle movement is almost immediate. There is little delay in power buildup.

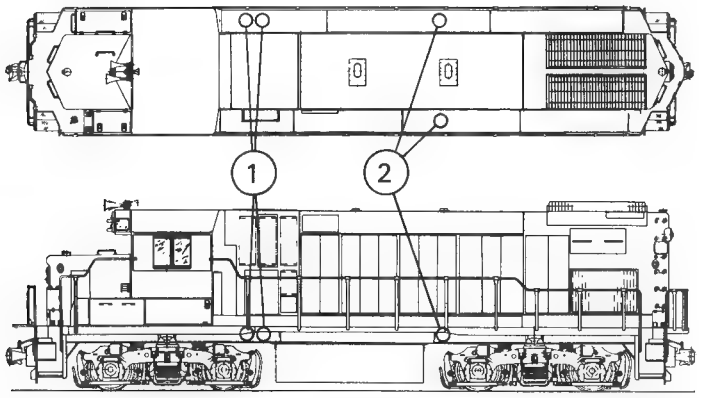
7. Throttle should be in IDLE before coming to a dead stop.

8. Reverser handle should be moved to change direction of travel only when locomotive is completely stopped.

DRAINING AIR RESERVOIRS AND FILTERS

The air reservoirs and filters should be drained at least once each day whether or not equipment is provided with automatic drain valves. Draining should be done at the time of crew change until a definite schedule is established by the railroad.

Momentarily open the No. 1 and No. 2 main reservoir drain valves, and the main reservoir dirt collector, Fig. 3-2, to purge condensate from the air system.



1. Main Reservoir Dirt Collector Drain Valve
2. Main Reservoir Drain Valve Locations

Fig.3-2 – Compressed Air System
Drain Valve Locations

COUPLING LOCOMOTIVES TOGETHER

When coupling units together for tandem unit operation, the procedure below should be followed:

1. Couple and stretch units to ensure couplers are locked.
2. Install control cable between units.
3. Attach platform safety chains between units.
4. Perform ground, engineroom, and engine inspections, as outlined in preceding articles.
5. Position cab controls for trailing unit operation as outlined in preceding articles. Remove reverser handles from all controllers to lock controls.

6. Connect air brake hoses between units.

7. Open required air hose cutout cocks on each unit.

8. Make a setup of the brakes to determine if brakes apply on each unit. Brakes then must be released to determine if all brakes release. The same procedure must be followed to check the independent brake application. Also, release an automatic service application by depressing the independent brake valve handle down. Inspect all brakes to determine if they are released.

COUPLING UNITS TOGETHER FOR DYNAMIC BRAKING

The locomotive, when equipped with basic dynamic brakes, makes use of electrical potential from the brake control rheostat to control braking strength by controlling excitation of the main generator field. This electrical potential is impressed upon a trainlined wire to control dynamic braking strength of all units coupled in tandem that are equipped with potential line brake control. However, the total braking effort of units coupled in tandem can become quite high. Carefully observe railroad rules regarding multiple unit dynamic braking in critical service.

COUPLING LOCOMOTIVE TO TRAIN

Locomotive should be coupled to train using the same care taken when coupling units together. After coupling, make the following checks:

1. Test to see that couplers are locked by stretching connection.

2. Connect air brake hoses.

3. Slowly open air valves on locomotive and train to cut in brakes.

4. Pump up air using the following procedure.

PUMPING UP AIR

After cutting in air brakes on train, note the reaction of the main reservoir air gauge. If pressure falls below trainline pressure, pump up air as follows:

1. Place generator field switch in off position.

2. Move reverser handle to neutral position.

3. Open throttle as needed to speed up engine and thus increase air compressor output.

NOTE

Throttle may be advanced to No. 5 if necessary. Engine should not, however, be run unloaded (as in pumping air) at speeds beyond throttle No. 5 position.

BRAKE PIPE LEAKAGE TEST

Prior to operating the air brake equipment, a leakage test must be performed. Brake pipe leakage tests should be made in accordance with the railroad operating rules and Power Brake Law.

STARTING A TRAIN

The method to be used in starting a train depends upon many factors such as, the type, weight and length of the train and amount of slack in the train; as well as the weather, grade and track conditions. Since all of these factors are variable, specific train starting instructions cannot be provided and it will therefore be up to the operator to use good judgment in properly applying the

power to suit requirements. There are, however, certain general considerations that should be observed. They are discussed in the following paragraphs.

A basic characteristic of the diesel locomotive is its high starting tractive effort, which makes it imperative that the air brakes be completely released before any attempt is made to start a train. It is therefore important that sufficient time be allowed after stopping, or otherwise applying brakes, to allow them to be fully released before attempting to start the train.

The locomotive possesses sufficiently high tractive effort to enable it to start most trains without taking slack. The practice of taking slack indiscriminately should thus be avoided. There will, however, be instances in which it is advisable (and sometimes necessary), to take slack in starting a train. Care should be taken in such cases to prevent excessive locomotive acceleration which will cause undue shock.

Proper throttle handling is important when starting trains since it has a direct bearing on the power being applied. As the throttle is advanced, a power increase occurs almost immediately, and power applied is at a value dependent upon throttle position. It is therefore advisable to advance the throttle one notch at a time when starting a train. A train should be started in as low a throttle position as possible, thus keeping the speed of the locomotive at a minimum until all slack has been removed and the train completely stretched. Sometimes it is advisable to reduce the throttle a notch or two at the moment the locomotive begins to move in order to prevent stretching slack too quickly or to avoid slipping.

When ready to start, the following general procedure is recommended.

1. Place isolation switch in RUN position.

2. Move reverser handle to the desired direction, either forward or reverse.

3. Place engine run and generator field switches in the on position.

4. Release both automatic and independent air brakes.

5. Open the throttle one notch every few seconds as follows:

   a. To No. 1 Loading will stop at a specific low value. This may be noted on the load indicating meter. At an easy starting place the locomotive may start the train.

NOTE

The design of the locomotive power control system makes it generally unnecessary to apply locomotive independent brakes or to manipulate the throttle between position No. 1 and IDLE during starting.

   b. To No. 2, 3, or higher (experience and the demands of the schedule will determine this) until the locomotive moves.

6. Reduce throttle one or more notches if acceleration is too rapid.

7. After the train is stretched, advance throttle as desired.

NOTE

When operating at full throttle to climb a hill or to accelerate, the wheel slip control system reacts so rapidly to correct minor slips by means of power reduction and sanding that the wheel slip light seldom comes on to indicate severe slips. This wheel slip corrective action is often seen at the load current indicating meter as a steady reduction of load current below that which is normally expected at full throttle for a given speed. Do not misinterpret this power reduction as a fault. It is merely the wheel slip control system doing its job and maintaining power at level within the adhesion conditions established by track and grade.

ACCELERATING A TRAIN

After the train has been started, the throttle can be advanced as rapidly as desired to accelerate the train. The speed with which the throttle is advanced depends upon demands of the schedule and the type of locomotive and train involved. In general, however, advancing the throttle one notch at a time is desired to prevent slipping.

The load indicating meter provides the best guide for throttle handling when accelerating a train. By observing this meter it will be noted that the pointer moves toward the right (increased amperage) as the throttle is advanced. As soon as the increased power is absorbed, the meter pointer begins moving toward the left. At that time, the throttle may again be advanced. Thus for maximum acceleration without slipping, the throttle should be advanced one notch each time the meter pointer begins moving toward the left until full power is reached in throttle position No. 8.

AIR BRAKING WITH POWER

The method of handling the air brake equipment is left to the discretion of the individual railroad. However, when braking with power, it must be remembered that for any given throttle position, the draw bar pull rapidly increases as the train speed decreases. This pull might become great enough to part the train unless the throttle is reduced as the train speed decreases. Since the pull of the locomotive is indicated by the amperage on the load meter, the operator can maintain a constant pull on the train during a slow down by keeping a steady amperage on the load meter. This is accomplished by reducing the throttle a notch whenever the amperage starts to increase. It is recommended that the independent brakes be kept fully released during power braking. The throttle must be in IDLE before the locomotive comes to a stop.

POWER AT STALL

Do not hold the train at standstill on a grade or with the brakes applied and the throttle open for power. Extensive damage to the traction motors is possible.

OPERATING OVER RAIL CROSSING

When operating the locomotive at speeds exceeding 40 km/h (25 MPH), reduce the throttle to No. 4 position at least 8 seconds before the locomotive reaches a rail crossing. If the locomotive is operating in No. 4 position or lower, or running less than 40 km/h (25 MPH), allow the same interval and place the throttle in the next lower position. Advance the throttle after all units connected in tandem have passed over the crossing. This procedure is necessary to ensure decay of motor and generator voltage to a safe level before the mechanical shock that occurs at rail crossings is transmitted to the motor brushes.

RUNNING THROUGH WATER

Under absolutely no circumstances should the locomotive be operated through water deep enough to touch the bottom of the traction motors. Water any deeper than 76 mm (3″) above the rail is likely to cause traction motor damage.

When passing through any water on the rails, exercise every precaution under such circumstances and always go very slowly, never exceeding 3 to 5 km/h (2 to 3 MPH).

WHEEL SLIP CORRECTION

Instantaneous reduction of locomotive power together with automatic sanding, functions to correct wheel slip. After adhesion is regained, a timed application of sand continues while power is smoothly restored. The system functions entirely automatically, and no action is required by the locomotive operator.

Depending upon the seriousness of the slipping condition, the wheel slip light may or may not flash on and off as the wheel slip control system functions to correct the slips. However, the wheel slip control system reacts so rapidly to correct minor slips that the wheel slip light seldom comes on to indicate severe slips. The wheel corrective action is often seen at the load current indicating meter as a steady reduction of load current below that which is normally expected at full throttle for a given speed. Do not misinterpret this power reduction as a fault. It is simply the wheel slip control system doing its job and maintaining power at a level within the adhesion conditions established by track and grade.

NOTE

Whenever possible, operation on grades should be at full throttle position. Throttle reduction during wheel slip is recommended only when:

1. Repeated wheel slip conditions cause severe lurching that may pull a train apart. (Such severe conditions may indicate the need for a helper or the need to take the train up the hill in two parts.)

2. In unusual conditions, simultaneous wheel slips may be incurred at low or stall speed. In this situation the performance of the equipment is directly related to the skill and judgment of the operator. Therefore, the operator must determine to apply sand to the rail and/or reduce throttle.

WHEEL SLIP LIGHT

If the wheel slip light blinks on and off persistently or burns continuously during locomotive operation, a pair of wheels may be sliding or circuit difficulty may exist. Due to the seriousness of sliding wheels, under such indications the locomotive should be IMMEDIATELY STOPPED and an investigation made to determine the cause. The wheels may be sliding due to a locked brake, damaged traction motor bearings, or broken pinion or gear teeth.

Repeated ground relay tripping, accompanied by unusual noises such as thumping or squealing, may also indicate serious traction motor trouble that should be investigated at once.

Do not allow any unit that must be isolated due to repeated wheel slip or ground relay action to remain connected in the tandem UNLESS IT HAS BEEN ABSOLUTELY DETERMINED THAT ALL OF ITS WHEELS ROTATE FREELY.

LOCOMOTIVE SPEED LIMIT

The maximum speed at which the locomotive can be safely operated is determined by the gear ratio. This ratio is expressed as a double number such as 62:15. The 62 indicates the number of teeth on the axle gear while the 15 represents the number of teeth on the traction motor pinion gear.

Since the two gears are meshed together, it can be seen that for this particular ratio the motor armature turns approximately four times for a single revolution of the driving wheels. The locomotive speed limit is therefore determined by the maximum permissible rotation speed of the motor armature. Exceeding this maximum could result in serious damage to the traction motors.

Various gear ratios are available to suit specific locomotive operating requirements. For each gear ratio, there is a maximum operating speed. This information is given in the "General Data" section at the beginning of this manual.

Although not basically applied, overspeed protective equipment is available for installation on locomotives. The equipment consists of an electro-pneumatic arrangement with many possible variations to suit specific requirements. In general, however, an electrical switch in the speed recorder is used to detect the overspeed. This switch in turn initiates certain air brake functions which reduce the train speed.

MIXED GEAR RATIO OPERATION

If the units connected in tandem are of different gear ratios, the locomotive should not be operated at speeds in excess of that recommended for the unit having the lowest maximum permissible speed. Similarly, operation should never be slower than the minimum continuous speed (or maximum motor amperage) for units having established short time ratings.

To obtain a maximum tonnage rating for any single application, Electro-Motive will, upon request, analyze the actual operation and make specific tonnage rating recommendations.

DYNAMIC BRAKING

Dynamic braking, on locomotives so equipped, can prove extremely valuable in retarding train speed in many phases of locomotive operation. It is particularly valuable while descending grades, thus reducing the necessity for using air brakes.

Depending on locomotive gear ratio, the maximum braking strength is obtained between 31 and 37 km/h (19 and 23 MPH). At train speeds higher than the optimum, braking effectiveness gradually declines as speed increases. For this reason, it is important that dynamic braking be started BEFORE train speed becomes excessive. While in dynamic braking, the speed of the train should not be allowed to "creep" up by careless handling of the brake.

To operate dynamic brakes, proceed as follows:

1. The reverser handle must be positioned in the direction of the locomotive movement.
2. Return throttle to IDLE for 10 seconds before proceeding.

WARNING

The 10 second delay must be accomplished before the braking handle is moved into SET UP position.

Braking delay occurs automatically. Do not misinterpret the delay as failure of the dynamic braking system.

It is possible for a sudden surge of braking effort to occur if the dynamic braking handle is open when the automatic delay times out.

3. Move the braking handle into SET UP position. This establishes the dynamic braking circuits. It will also be noted that a slight amount of braking effort occurs, as evidenced by the load current indicating meter.

4. After the slack is bunched, the dynamic braking handle is moved to control dynamic braking strength. As it is advanced out of SET UP, it will be noted that the engine speed automatically increases.

5. Braking effort may be increased by slowly advancing the handle to FULL 8 position if desired. Maximum braking current can occur over a wide range of braking handle positions. This range allows braking effort to increase as train speed increases. The tendency is to hold train speed relatively constant for a given braking handle position when conditions result in less than the maximum allowable current.

NOTE

On units equipped for "Grid Current Trainline Control" of dynamic braking, maximum current is limited by braking handle position, maximum dynamic braking is obtainable only with braking handle in the maximum position. Braking current will generally be at or near the maximum obtainable at the given handle position, and the tendency for train speed to hold steady for a given handle position is not as effective as with the basic brake.

6. With automatic regulation of maximum braking strength, the brake warning light on the controller should seldom give indication of excessive braking current. If the brake warning light does flash on however, movement of the braking handle should be stopped until the light goes out.

7. If the light fails to go out after several seconds, move the braking handle back slowly until the light does go out. After the light goes out, the handle may again be advanced to increase braking effort.

NOTE

The brake warning light circuit is "trainlined" so that a warning will be given in the lead unit if any unit connected in tandem is generating excessive current in dynamic braking. Thus regardless of the load indicating meter reading or braking handle position (which may be less than maximum), whenever the warning light comes on, it should not be allowed to remain on for any longer than 2 or 3 seconds before steps are taken to reduce braking strength.

If brake warning indications are repeated, the locomotive should be taken out of dynamic braking. Locomotives connected in tandem will then operate normally under power and during dynamic braking, but with reduced total braking effort.

8. When necessary, the automatic brake may be used in conjunction with the dynamic brake. However, the independent brake must be KEPT FULLY RELEASED whenever the dynamic brake is in use, or the wheels may slide. As the speed decreases below 16 km/h (10 MPH) the basic dynamic brake becomes less effective. When the speed further decreases, it is permissible to completely release the dynamic brake by placing the handle in OFF position, applying the independent brake simultaneously to prevent the slack from running out.

The locomotive can be operated in dynamic braking when coupled to older units that are not equipped with brake current limiting regulators. If all the units are of the same gear ratio, the unit having the lowest maximum brake current rating should be placed as the lead unit

when connected in tandem. The operator can then operate and control the braking effort up to the limit of the unit having the lowest brake current rating, without overloading the dynamic brake system of a trailing unit. The locomotives coupled in tandem MUST always be operated so as not to exceed the braking current of the unit having the lowest maximum brake current rating.

Units equipped with dynamic brake current limiting regulators can be operated in multiple with other locomotives in dynamic braking regardless of the gear ratio or difference in the maximum brake current ratings.

DYNAMIC BRAKE WHEEL SLIP CONTROL

During dynamic braking, each series group of two traction motors is connected in parallel with each dynamic braking resistor grid circuit and with the other series connected traction motors. With this arrangement, when a wheel slips it may be motored by other motors in the system. This in effect makes a wheel slip during dynamic braking somewhat self correcting. However, the parallel arrangement of dynamic braking resistor grids and traction motors is such that the full response of the wheel slip control system is available during dynamic braking as well as during power operation. The precise and immediate regulation maintained, plus the motoring effect created by the parallel arrangement, provides extremely stable dynamic brake operation.

In addition to the above, a bridge circuit is employed to protect against the possibility of simultaneous slips that otherwise may not be detected.

When a pair of wheels is detected tending to rotate at a slower speed, the retarding effort of the traction motors in the unit affected is reduced (traction alternator field excitation is reduced in the unit affected) and sand is automatically applied to the rails. When the retarding effort of the traction motors in the unit is reduced, the

tendency of the wheel set to rotate at a slower speed is overcome. After the wheel set resumes normal rotation, the retarding effort of the traction motors returns (increases) to its former value. Automatic sanding continues for 3 to 5 seconds after the wheel slide tendency is corrected.

OPERATION IN HELPER SERVICE

Basically, there is no difference in the instructions for operating the locomotive as a helper or with a helper. In most instances, it is desirable to get over a grade in the shortest possible time. Thus, wherever possible, operation on the grades should be in the full throttle position. The throttle can be reduced, however, where wheel slips cause lurching that may threaten to break the train.

ISOLATING A UNIT

When the occasion arises where it becomes advisable to isolate a locomotive unit, observe the following:

1. When operating under power with multiple units, a unit may be isolated at any time, but discretion as to timing and necessity should be used.

2. When operating in dynamic braking, it is important to get out of dynamic braking before attempting to isolate the unit. This is done by reducing the braking handle to OFF. The isolation switch can then be moved to ISOLATE position to eliminate the braking on that unit. If the braking is resumed, other units will function normally.

CHANGING OPERATING ENDS

When locomotives coupled in tandem include two or more units with operating controls, the following procedure is recommended in changing from one operating end to the opposite end.

ON END BEING CUT OUT

1. Move the automatic brake valve handle to service position and make a 138 kPa (20 psi) reduction.

2. After brake pipe exhaust stops, place cut-off pilot valve in OUT position by pushing knob in and turning to the desired position.

3. Place independent brake handle in fully released position.

4. Place multiple unit valve in the desired TRAIL position, depending on trailing unit brake equipment.

5. Position the automatic brake valve handle in the handle off position.

6. With dynamic brake handle in OFF position and throttle in IDLE, place the reverser handle in neutral position and remove to lock the controls.

7. Place all switches in the off position. Be absolutely certain that the control and fuel pump switch, generator field switch, and engine run switch are in the off position.

8. At the engine control panel, place headlight control switch in proper position for trailing unit operation. Place other switches on as needed.

9. At the circuit breaker panels and circuit breaker compartment, all circuit breakers in the black areas are to remain in the on position.

10. After completing the operations outlined in the preceding steps, move to the cab of the new lead unit.

ON END BEING CUT IN

1. At the control stand, make certain the generator field switch is off.

2. Insert reverser handle and leave in neutral position.

3. Place automatic brake valve handle in suppression position to nullify any safety control, overspeed, or train control used.

4. Insert independent brake valve handle (if removed) and move handle in full independent application position.

5. Position cut-off pilot valve to IN position. On units equipped with a three position cut-off pilot valve, position valve to either FRT or PASS depending on make-up of train.

6. Place multiple unit valve in LEAD position.

7. At the circuit breaker panels and circuit breaker compartment, check that all circuit breakers in the black areas are in the on position.

8. At the engine control panel, place the headlight control switch in proper position, and other switches on as needed.

9. Place the engine run, control and fuel pump, and generator field switch in on position. Other switches may be placed on as needed.

STOPPING ENGINE

There are six ways to stop the engine:

1. Press stop button on engine control panel.

   When the locomotive is standing still or under power, the isolation switch should be placed in STOP position. The stop button can then be pressed in to stop the engine. Since the reaction of the stop button is instantaneous, it need not be held in.

2. Press emergency fuel cut-off button, when equipped.

   Emergency fuel cut-off pushbuttons are located near each fuel filler opening. These pushbuttons operate in the same manner as the stop button and need not be held in nor reset.

3. Use injector control lever.

   The injector control lever can be operated to override the engine governor and move the injector racks to the no fuel position.

4. Close the low water detector test cock.

   When the low water detector trips, oil is dumped from the governor low oil shutdown device, stopping the engine.

5. Use throttle handle.

   To stop all engines, "on the line" move the throttle to the IDLE position, pull the handle out and away from the controller, and move it beyond IDLE to the STOP position.

6. Pull out low oil shutdown plunger on the side of the governor.

CAUTION

Observe freezing weather precautions whenever an engine is shut down during cold weather.

FREEZING WEATHER PRECAUTIONS

As long as the diesel engine is running, the cooling system will be kept adequately warm regardless of ambient (outside) temperatures encountered. It is only when the engine is shut down or stops for any reason that the cooling system requires protection against freezing.

To drain cooling system, open engine water drain valve located at the pit between the engine and accessory rack. The entire system will drain provided the following valves are positioned properly.

1. If equipped with hot water cab heaters the supply/return valve should be placed in the drain (handle vertical) position.

2. If equipped with fuel preheater (located at the equipment rack) both the water supply and return valves should be opened.

After system pressure is released, remove the water tank fill cap, Fig. 3-3, to allow drainage at an increased rate.

CAUTION

If a hot engine is drained, always allow the engine to cool before refilling with fresh coolant.

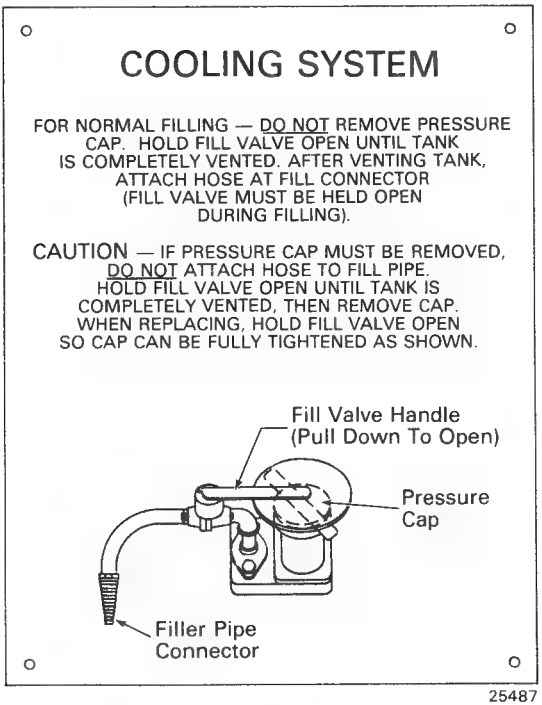


Fig.3-3 – Cooling System Pressure Cap And Fill/Relief Arrangement

DRAIN HOT WATER CAB HEATER SYSTEM, ONLY (If Equipped)

1. Place cab heater supply and return valve in drain (handle vertical) position.

2. Engine water drain valve is to remain closed.

DRAIN FLUSH TOILET (If Equipped)

1. Flush toilet until all water has drained from tank.
2. Turn off electric toilet tank heater (if equipped).
3. Remove pipe plug from bottom of toilet flush piping.

DRAIN WATER COOLER (If Equipped)

1. Remove and empty water bottle.
2. Drain remaining water in cooler by holding in the spigot button.
3. Turn off electric power to water cooler (if equipped).

CAUTION

On units equipped with special automatic cooling system drain, the automatic water drain circuit breaker must be in the ON position.

TOWING LOCOMOTIVE DEAD IN TRAIN

When a locomotive unit equipped with air brakes is placed within a train, to be towed, control and air brake equipment should be set as follows:

1. Drain all air from main reservoirs and air brake equipment.
2. Place the multiple unit valve in DEAD position.
3. Place cut-off pilot valve in OUT position.
4. Place independent brake valve handle in release position.
5. Place automatic brake valve handle in handle off position.

6. Cut in dead engine feature by turning cutout cock, Fig. 2-7, to open (90° to pipes) position. The dead engine cutout cock is located on the air brake rack.

7. Position the cab controls as follows:

   a. Battery switch open.

   b. All circuit breakers OFF.

   c. All control switches OFF.

   d. Starting fuse removed.

   e. Throttle in IDLE, dynamic brake handle in OFF position. Remove reverser from controller to lock the controls.

CAUTION

If there is danger of freezing, the engine cooling system should be drained. Refer to Freezing Weather Precautions.

LEAVING LOCOMOTIVE UNATTENDED

If at any time it is necessary to leave the locomotive unattended while the engine is running, the following procedure should be adhered to.

1. Observe all railroad safety precautions.

2. Place engine run and generator field switches in the off (down) position.

3. Place throttle in IDLE and dynamic brake handle in OFF position. Remove reverser handle from controller to lock the controls.

SECTION 4

TROUBLESHOOTING

INTRODUCTION

This section covers operational problems that may occur on the road and suggests action that may be taken by the operator in response to the trouble.

Safety devices automatically protect equipment in case of faulty operation of almost any component. In general this protection is obtained by one of the following methods.

1. Complete shutdown of the diesel engine, or complete elimination of a function such as dynamic braking.

2. Unloading of the diesel engine and restriction to idle engine speed. In some instances manual resetting of the function may be necessary, or automatic resetting after a time delay may be provided.

3. Rough back-up regulation for protection of equipment.

Condition	Probable Cause	Suggested Operator's Response
Lead unit HOT ENGINE light on; alarm bell ringing; engine running, but engine speed and power reduced (unless equipped with reduced power nullification).	Temporary operating condition. This condition is more likely to occur during tunnel or desert operation.	No action unless alarm persists. If alarm continues for more than a few minutes, check that shutters are open and radiator blower motors are operating. Also check for proper coolant level. **CAUTION** If it is necessary to shut down the engine in freezing weather, the cooling system should be drained or otherwise protected to prevent freezing.
	Low coolant level.	The unit should be shut down if coolant level is low or if there are coolant leaks.

	Shutters not operating properly.	If shutters are closed, the manual shutter control valve may be incorrectly set to TEST position. The valve should be set to OPERATION position. The unit should be shut down if the shutters do not open.
	Radiator blower motor not operating.	If radiator blower motor is not operating, the 200-ampere fuses, located in the AC cabinet, may be open. The unit must be shut down before replacing the fuses. The unit should be shut down if the blower motor does not operate.
Full engine speed and power not obtainable. Annunciator ENG. AIR FILT. light will not reset.	Plugged engine air filters.	Operation may continue. Engine speed and power restricted at upper throttle positions. Condition to be reported at first maintenance point.

Condition	Probable Cause	Suggested Operator's Response
Lead unit H.V. GRD./ FAULT light on; alarm bell ringing.	Lead unit ground relay operation.	If unit is equipped with automatic ground relay reset, it will reset automatically within 10 seconds unless the total number of ground relay operations is excessive. If unit is not equipped with automatic ground relay reset, take no action for 10 seconds; then press the ground relay reset pushbutton on the control stand, if so equipped. The ground relay pushbutton should not be pressed more than three times within any consecutive 30 minute period.

If ground relay operation is caused by traction motor flashover or weakened traction motor insulation, it may be possible to continue operation of the unit by cutting out the defective traction motor. Observe instructions on engine control panel when necessary to cut out a traction motor.

The unit should be isolated and shut down if more than three ground relay operations occur within any consecutive 30 minute period or if the automatic ground relay reset device locks out.

Condition	Probable Cause	Suggested Operator's Response
Lead unit NO BATT. CHARGE/NO POWER light on; alarm bell ringing; engine at idle speed or shut down.	No companion alternator output voltage.	If the unit shuts down, check that the 15-ampere auxiliary generator field circuit breaker is on. Also check that the 150-ampere auxiliary generator fuse is in good condition. In addition, check the engine overspeed trip lever. Replace fuse, reset the circuit breaker or the engine overspeed trip lever and restart engine. If the overspeed trip lever or the fuse/circuit breakers trip again, the unit should be isolated and shut down. If the unit remains at idle speed, check the 15-ampere AC CONTROL circuit breaker. If the above fuse or circuit breakers are not open and the engine overspeed trip lever is set, the unit should be isolated and shut down.

Lead unit GOVERNOR SHUTDOWN/6TH THROTTLE knockdown light on; alarm bell ringing; engine shut down.	Low water detector button tripped.	If both the HOT ENGINE and the GOVERNOR SHUTDOWN lights are on, the unit should be isolated. Do not attempt to restart the engine. Report engine shutdown to authorized maintenance personnel. If the crankcase pressure detector button is set, but the low water detector button and the governor low oil plunger are tripped, perform thorough check of the following items. 1. Cooling water level satisfactory. 2. Cooling water temperature satisfactory. 3. No visible oil leaks or water leaks. 4. Governor oil level satisfactory. 5. Engine lube oil level satisfactory.

NOTE

If the light comes on and the engine continues to run but will not produce full speed and power, operation may continue. Report the condition to maintenance personnel.

Condition	Probable Cause	Suggested Operator's Response
		If all items are normal, the engine may be restarted and placed on the line after resetting the governor low oil shutdown plunger. The low water reset button may be reset after the engine has started. If the GOVERNOR SHUTDOWN light comes on again, the unit should be isolated and shut down.
	Hot oil or low governor oil.	If the low water detector button and the crankcase pressure detector button are set but the governor low oil plunger is tripped, do not attempt to restart the engine. Isolate the unit and notify authorized maintenance personnel.
	Crankcase pressure detector tripped.	**WARNING** If crankcase pressure detector has tripped, make no further engineroom inspections. Do

		not attempt to restart the engine. Isolate the unit. If freezing conditions are possible, drain the cooling system or otherwise protect the system from freezing.
Intermittent WHEEL SLIP light indications.	Normal wheel slip correction under severe conditions.	No action required. Do not reduce throttle unless slipping is so severe that it threatens to break the train.
Excessive WHEEL SLIP light indications.	Locked sliding wheels.	Check that all wheels on the locomotive rotate freely. Do not operate a locomotive unless all wheels rotate freely.
TURBO AUX PUMP light on.	Normal condition for 35 minutes after engine start or stop.	No action necessary.
PCS OPEN light on.	Penalty brake application.	**NOTE** Observe railroad regulations after any penalty or emergency brake application.

Control	Probable Cause	Suggested Operator's Response
		To regain power, move throttle to IDLE and automatic brake handle to suppression position, then to release.
	Emergency brake application (on locomotive equipped for PCS to open upon emergency brake application).	Move throttle to idle. Move automatic brake handle to emergency position and wait 45 seconds, then move automatic brake handle to release position.
Engine will not crank.	Circuit breakers or switches not in proper position.	Refer to Section 3 for engine starting procedures.
	EP module not operating properly, if equipped.	Bar the engine over one full revolution, then hold BYPASS switch on EP module closed while cranking engine.

	Immersion heater or external battery charging cables connected.	Disconnect immersion heater or external battery charging cables.
	Starting fuse defective.	Check fuse and replace if necessary.
Alarm bell rings; no alarm lights on in lead unit.	Trailing unit hot engine.	Refer to lead unit HOT ENGINE.
	Trailing unit low water detector button tripped.	Refer to lead unit GOVERNOR SHUTDOWN.
	Trailing unit hot oil or low governor oil.	Refer to lead unit GOVERNOR SHUTDOWN.
	Trailing unit crankcase detector button tripped.	Refer to lead unit GOVERNOR SHUTDOWN.
	Trailing unit H.V. GRD./ FAULT. operation.	Refer to lead unit H.V. GRD./ FAULT.
	Trailing unit - No companion alternator output voltage.	Refer to lead unit NO BATT. CHARGE/NO POWER light on.